ORIGINAL ARTICLE

Effectiveness of Seven Types of Sealants: Retention after One Year

Ahmed M Hassan[1], Shukry G Mohammed[2]

Abstract

Aim: The aim of this study is to determine the retention rate and pattern of different pit and fissure sealants placed on the occlusal surface of newly erupted first permanent molars after 3, 6, 9, and 12 months.

Materials and methods: Seventy children were enrolled in this study. They divided into seven groups ($m = 10$) according to the type of the sealant. The four permanent first molars of each child were sealed. The sealant was applied according to the instructions from the manufacturer. A clinical evaluation was carried out at 3, 6, 9, and 12 months. The clinical observations were divided into three categories: total retention (TR), partial retention (PR), and total loss (TL).

Results: The resin-based sealant performed better than the glass ionomer-based sealant except for the Ketac Molar Easymix. At 3 months, there was no significant difference among all the tested groups ($p > 0.05$), while at 6, 9, and 12 months, there was a highly significant difference ($p < 0.001$). The glass carbomer sealant showed the least retention rate at all intervals.

Conclusion: With an exception of the Ketac Molar Easymix, resin-based sealers performed better than glass ionomer-based sealers.

Clinical significance: A proper application of pit and fissure sealant will decrease the chance for caries development in newly erupted teeth.

Keywords: Children, Pit and fissure, Retention, Sealant.

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Introduction

Nowadays, there is a shift from treatment to prevention of caries, thus, resulting in the conservation of tooth structure.[1] Tooth decay is a multifactorial disease in which acidogenic and aciduric bacteria play the most important role. Untreated carious lesions may lead to pain, systemic infections, hospitalization, or even death.[2] About 50% of caries in school children located on the occlusal surface. This is due to the presence of pits and fissures with their irregularities and invaginations.[3] There are two main strategies used to deal with deep pits and fissures: topical fluoride application and pit and fissure sealants. Topical fluoride application is more effective in smooth surfaces of the tooth, whereas the pit and fissure sealant is used successfully in the occlusal surface.[4] Pit and fissure sealants are plastic coatings cover the pits and fissure. They prevent oral bacteria and dietary carbohydrates from accumulation within the pits and fissures and from developing the acidic media which is essential in caries development. One advantage of pit and fissure sealant is an easy technique with no need for local anesthesia. Although the success of pit and fissure sealant depends on its long-term retention on the tooth surface, retention of sealant material in the fissure is still a major problem that decreases its efficacy.[1,2,5]

Fissure sealant was first introduced in the mid-1960s in the form of some materials derived from cyanoacrylates family but their use was restricted to experimental studies. The first used fissure sealant with resin base was marketed by the NUVASEAL trademark in 1971.[6] Two approaches are used nowadays for pit and fissure sealant: resin-based approach and glass ionomer-based approach. To enhance the penetration of the resin into the narrow and irregular anatomy of the pits and fissures, the filler content is markedly decreased to decrease the viscosity of the resin-based sealants. On the contrary, the continuous development of glass ionomer-based sealants has been resulted in a change of its composition. The powder particle size is reduced and a fluroapatite has been added.[3,7] Some manufactures added a colorant agent to the sealant to aid in the recognition of the presence of sealants on the tooth surface.[4] The ideal pit and fissure sealant should be biocompatible, anticariogenic, have adequate bond strength, and good marginal adaptation. It also should have good resistance to abrasion and wear, and should be inexpensive.[8]

The newly erupted molars are more susceptible to caries development. Two main factors contribute to this fact. First, they are less mineralized than those exposed to the minerals in the oral cavity for many years. Second, there is a difficulty in access for oral hygiene measures.[4,9] Hence, in the present study, we compared the retention pattern and rate of seven pit and fissure sealants placed on the occlusal surface of newly erupted permanent first molars.

Materials and Methods

The present study was carried out in Al-Farabi Colleges for Dentistry and Nursing, Riyadh, KSA. Seventy children who reported to the hospital in the age group 8 to 10 years were selected for the study.

[1]Department of Restorative Dental Science, Al-Farabi Colleges for Dentistry and Nursing, Riyadh, Saudi Arabia

[2]Department of Preventive Dental Sciences, Al-Farabi Colleges for Dentistry and Nursing, Riyadh, Saudi Arabia

Corresponding Author: Ahmed M Hassan, Department of Restorative Dental Science, Al-Farabi Colleges for Dentistry and Nursing, Riyadh, Saudi Arabia, e-mail: ahmed.altabbakh@alfarabi.edu.sa

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The inclusion criteria for enrolment in this study were the following: good oral hygiene, cooperative children with no caries in their teeth, and fully erupted first permanent molar. The exclusion criteria were the following: bad oral hygiene, uncooperative, children having caries in their teeth, and mentally challenged children. The nature and objectives of the study as well as the possible discomfort and benefits were explained and a written informed consent was obtained from the parents. Children whose parents declined to sign the consent form were excluded from the study. Ethical approval for the study was also obtained from the research unit in Al-Farabi Colleges for Dentistry and Nursing, Riyadh, KSA.

After selection of the children, they were divided into seven groups ($n = 10$) according to the type of pit and fissure sealant. For each group, the four first permanent molars were sealed with a single sealant. The seven used sealants were the following: (group I) Clinpro (3M, St. Paul, USA), (group II) Delton FS+ (Dentsply International, York, PA), (group II) Fisseal (ProMedica, Neumunster, Germany), (group IV) Fuji VII GIC (GC Corporation, Tokyo, Japan), (group V) Glass Carbomer (First Scientific Dental, Elmshorn, Germany), (group VI) Helioseal F (Ivoclar Vivadent, NY), and (group VII) Ketac Molar Easymix (3MESPE, Seefeld, Germany).

Through scaling procedures were carried out for each child before conducting the study. A single operator carried out the scaling procedures for all groups. This was followed by prophylaxis using a slurry of pumice and a rotating brush at low speed to ensure complete removal of calculus or food debris from the pits and fissures. At the end, the occlusal surface of the four first permanent molars was flushed with water and air dried.

Prior to sealant application procedures, a rubber dam was applied for the selected molar. The occlusal surface then etched with the 37% phosphoric acid Scotchbond etchant (3MESPE, St. Pauls, Minneapolis, MN, USA) for 30 seconds, then rinsed for 10 seconds, and air dried for 10 seconds. The etching was confirmed by a dull frosty-white appearance of the enamel. If etching was not confirmed, the etching step was repeated. After the etching procedure, each sealant was applied according to the instructions from the manufacture. The occlusion was checked after setting of the sealant by articulating paper and any premature contact was removed. Immediate postoperative retention of the sealant was checked by trying to tack off the sealant with an explorer. If the sealant was dislodged from the tooth, the whole procedure was repeated.

All cases were clinically evaluated after 3, 6, 9, and 12 months of application. The examination results were categorized into three groups:

- TR: the sealant was present intact with no fracture or loss (score 1)
- PR: the sealant was present but there were some fractures (score 2)
- TL: the sealant was almost absent (score 3)

The collected data were then subjected to statistical analysis using SPSS software version no. 20.

Results

The present study assessed the retention of seven types of pit and fissure sealants in 70 children at the age of 8–10 years. The retention pattern and the rate of all tested materials at different time intervals are listed in Table 1 and illustrated in Figures 1 to 4. The highest retention rate (total and partial) was recorded for group I (Clinpro), group II (Delton FS+), group III (Feseal), and group VII (Ketac Molar Easymix) with 100% retention rate at 3 months. The lowest retention rate was recorded for group V (Glass Carbomer) with 40% of the retention rate at 12 months.

The Chi-square test was used to assess quantitatively if the differences in observations among the different groups were statistically significant or not at the different time intervals. On the one hand, a *p* value of 0.28 at 3 months indicated that the difference in the retention rate among the different groups was statistically insignificant. On the other hand, a *p* value of 0.001 at 6, 9, and 12 months indicated that there was a significant difference among the tested groups.

A comparison of the mean scores of each group at the different time intervals is listed in Table 2 and illustrated in Figure 5. The lowest mean score was recorded for group VII (Ketac Molar Easymix) at 3 months (1.10 ± 0.30), while the highest mean score was recorded

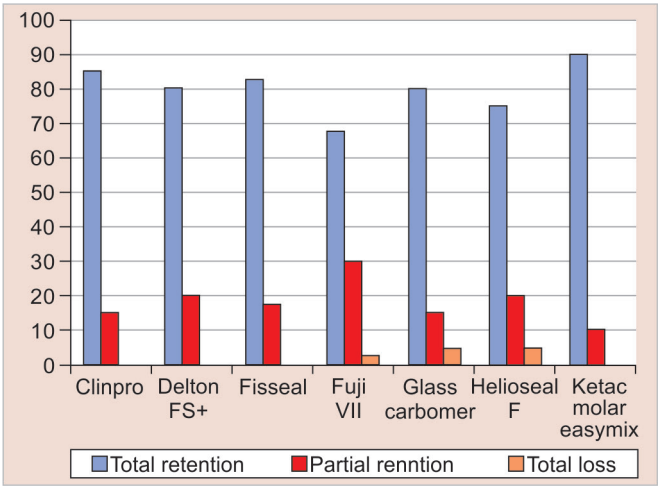

Fig. 1: Retention pattern and rate of all tested materials at 3 months

Table 1: Retention pattern and rate of all sealants at different time intervals

	3 months (%)			*6 months (%)*			*9 months (%)*			*12 months (%)*		
Sealant	*TR*	*PR*	*TL*	*TR*	*PR*	*TL*	*TR*	*PR*	*TL*	*TR*	*PR*	*TL*
Clinpro	85	15	0	82.5	15	2.5	72.5	25	2.5	62.5	32.5	5
Delton FS+	80	20	0	65	32.5	2.5	55	37.5	7.5	42.5	50	7.5
Fisseal	82.5	17.5	0	80	17.5	2.5	72.5	20	7.5	62.5	22.5	15
Fuji VII	67.5	30	2.5	57.5	37.5	5	47.5	45	7.5	30	57.5	12.5
Glass carbomer	80	15	5	50	15	35	30	27.5	42.5	20	20	60
Helioseal F	75	20	5	70	22.5	7.5	62.5	27.5	10	50	35	15
Ketac Molar Easymix	90	10	0	75	20	5	72.5	20	7.5	62.5	25	12.5

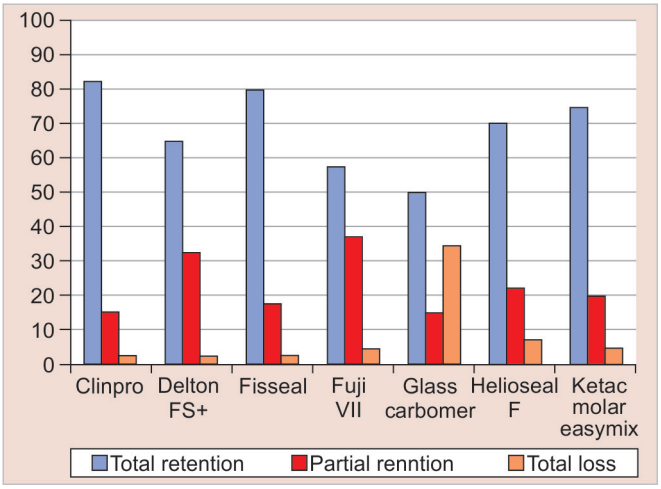

Fig. 2: Retention pattern and rate of all tested materials at 6 months

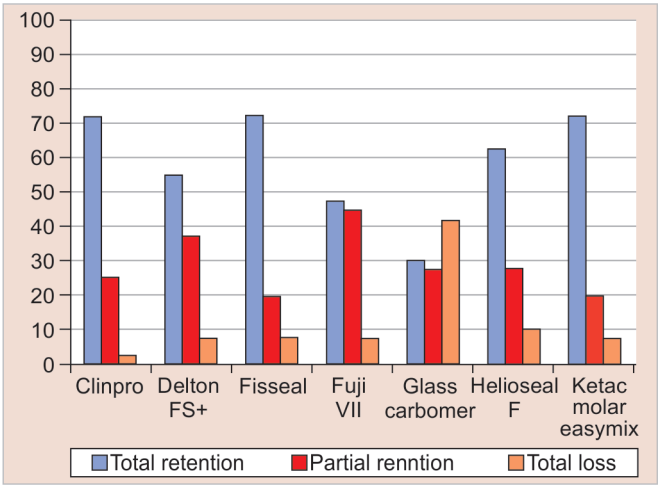

Fig. 3: Retention pattern and rate of all tested materials at 9 months

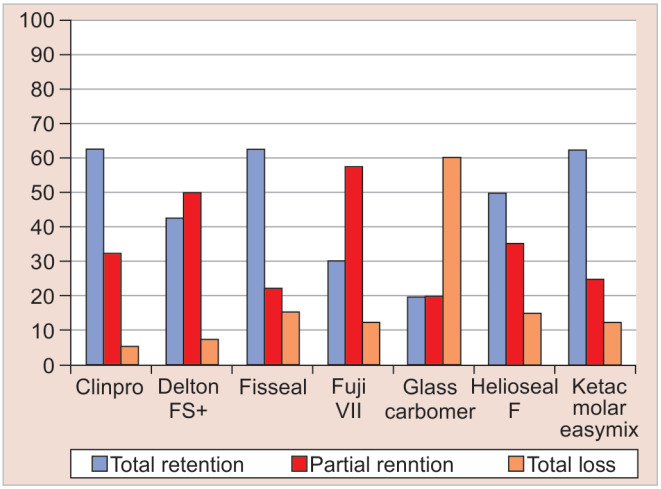

Fig. 4: Retention pattern and rate of all tested materials at 12 months

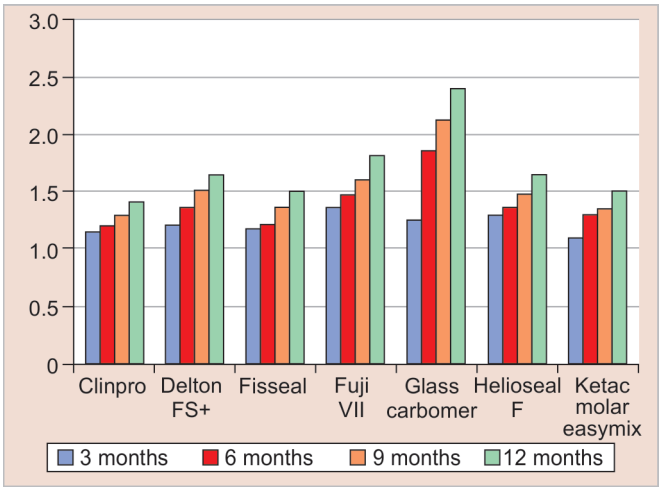

Fig. 5: Comparison of the mean scores of each group at the different time intervals

Table 2: Mean scores and standard deviations of all sealants at different time intervals

Sealant	*3 months ± SD*	*6 months ± SD*	*9 months ± SD*	*12 months ± SD*
Clinpro	1.15 ± 0.36	1.20 ± 0.46	1.30 ± 05.1	1.42 ± 0.59
Delton FS+	1.2 ± 0.40	1.37 ± 0.54	1.52 ± 0.64	1.65 ± 0.62
Fisseal	1.17 ± 0.38	1.22 ± 0.47	1.35 ± 0.62	1.52 ± 0.75
Fuji VII	1.35 ± 0.53	1.47 ± 0.59	1.60 ± 0.63	1.82 ± 0.63
Glass Carbomer	1.25 ± 0.54	1.85 ± 0.92	2.12 ± 0.85	2.40 ± 0.81
Helioseal F	1.30 ± 0.56	1.37 ± 0.62	1.47 ± 0.67	1.65 ± 0.73
Ketac molar Easymix	1.10 ± 0.30	1.30 ± 0.56	1.35 ± 0.62	1.50 ± 0.71
Total	1.21 ± 0.45	1.40 ± 0.64	1.53 ± 0.70	1.71 ± 0.75

for group V (Glass Carbomer) at 12 months (2.40 ± 0.81). One-way ANOVA was used to compare the mean scores of all groups at the different time intervals. On the one hand, at 3 months, the *p* value was 0.18 that indicates there was no statically significant difference among the different groups. On the other hand, at 6, 9, and 12 months, the *p* value was <0.001 that indicates the difference was statistically significant, so the *post hoc* Tukey test was performed. At 6 months, there was a significant difference ($p < 0.05$) among the mean score of group V (Glass Carbomer) and the mean scores of the rest groups except group IV (Fuji VII) in which the *p* value was 0.09, while at 9 and 12 months, there was a significant difference ($p < 0.05$) among the mean score of group V (Glass Carbomer) and the mean scores of all remaining groups. Unless for group V (Glass Carbomer), there was no significant difference among the remaining groups at any time interval.

Regardless of the tested material, Table 3 lists the retention patterns at the different time intervals. The highest TR was recorded at 3 months (80%), whereas the highest TL was recorded at 12 months (18.2%). This is illustrated in Figure 6.

Discussion

Pits and fissures on the occlusal surface of the teeth are the main sight for caries development in children.[10] The attempts to alter the morphology of retentive pits and fissures were started as early as 1920.[11] Nowadays, it is well established that sealing of retentive pits and fissures is an effective method for caries prevention in newly erupted teeth. It is also considered a cost-effective method as the tooth will be maintained in a healthy state for a longer time.[12]

Table 3: Retention pattern at different time intervals regardless to the sealant type

	3 months		*6 months*		*9 months*		*12 months*	
Retention pattern	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
TR	224	80	192	68.6	165	58.9	132	47.1
PR	51	18.2	64	22.8	81	28.9	97	34.6
TL	5	1.8	24	8.6	34	12.1	51	18.2

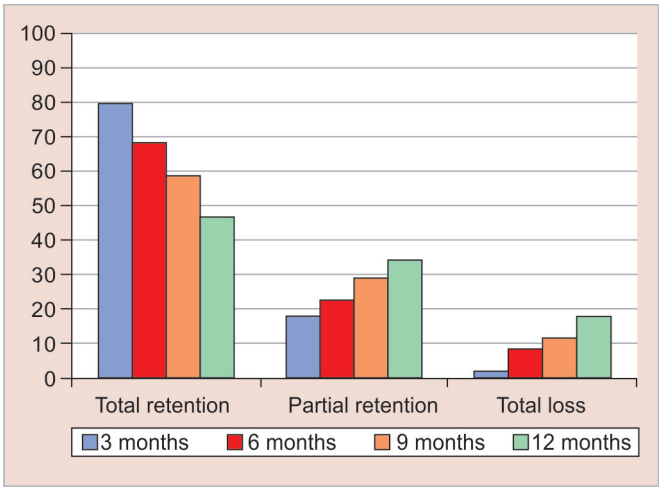

Fig. 6: Retention patterns at the different time intervals regardless to the tested materials

Currently, we have two categories of pit and fissure sealants available in the market: resin-based and glass ionomer-based sealants.[13]

Resin-based sealants alter of the occlusal anatomy by sealing the retentive pits and fissure and changing them into nonfood accumulating areas, whereas glass ionomer-based sealants depend on the local presence of fluoride. Unfortunately, there are many factors that prevent the penetration of such materials into pits and fissures.[10,14] These factors include salivary pellicle and end products of carbohydrate metabolism. So, thorough prophylaxis is mandatory before pit and fissure sealant application.[14]

Retention of pit and fissure sealants in the occlusal surface is very important in the success of this treatment.[11,15,16] The loss of pit and fissure sealant may be attributed to two main causes. In case of resin-based pit and fissure sealants, the main cause is the difference in the coefficient of thermal expansion. This difference will create a stress at the enamel–sealant interface with an ultimate result of debonding, while for glass ionomer-based pit and fissure sealants, the cause is disintegration of the sealants due to its solubility as they are hydrophilic materials.[17] On the contrary, retention of pit and fissure sealant cannot be considered alone as an indicator for the caries prevention efficacy of such materials.[18]

In this study, the highest retention rate was recorded at 3 months interval, whereas the lowest retention rate was recorded at 12 months interval. Resin-based sealant performed better than glass ionomer-based sealants except for the Ketac Molar Easymix group. This result is in agreement with other studies.[9,17] This is may be attributed to the better adaptation of the resin sealant at the occlusal surface. This allows these materials to withstand the applied occlusal forced in a better manner. On the one hand, the improved wear resistance of the resin-based sealer will resist the abrasive force of the opposing dentition.[18] One study related the longer retention rate of resin-based sealants to the ease of manipulation an unlimited working time.[12] On the other hand, microleakage associated with glass ionomer-based material is greater than resin-based materials.[19,20] This may contribute to loss of such sealants more than resin-based ones. Glass ionomer-based sealants also suffer from low wear resistance.[13] This may also contribute to the early loss of glass ionomer-based sealants. Low sensitivity to moisture contamination and the ability to release fluoride are considered major advantages of glass ionomer-based sealants that counteract the negative effect of low retention rate.[12,13,21]

On one the hand, in this study, Glass Carbomer demonstrated the lowest retention rate among all tested materials. This result is in accordance with another study.[7] They relate the short survival rate of Glass Carbomer to manufacture's issues. They claimed that the used material in their study was produced at a below-standard level. Other study demonstrated a sever microleakage and internal crack of Glass Carbomer.[22] On the other hand, another study concluded that the frequency of Glass Carbomer sealant remnants in pits and fissure is not lower than those of glass ionomer or resin sealants.[23] The reason for this disagreement may be due to the difference in the observation period. In our study, the overall observation period was 12 months, while in their study, the observation period extended for 3 years.

Regarding resin-based sealants, our results revealed that unfilled resin sealer Clinpro showed a high retention rate than filled resin sealant Helioseal F. Other studies also concluded the same results.[10,14,24] Low filler content of Clinpro when compared to Helioseal F resulted in low viscosity.[24] Low viscosity of unfilled resin sealant enables it to penetrate deeper in the narrow and irregular anatomy of the fissures. All tested pit and fissure sealants showed a better performance at 3-month intervals. The retention rate was reduced at each successive time interval. This result is in accordance with other studies.[5,7,9,10] The challenging media of the oral cavity without a doubt plays a significant role in decreasing the survival rate of all restorative material over an extended period of time. The continuous changes in pH and heat of the oral cavity play a deleterious effect on the restorative material.[25]

Despite all the efforts made to prevent caries development in newly erupted teeth, oral hygiene and low cariogenic diet intake remain the cornerstones to reduce the caries risk. One study emphasizes the governmental role to introduce oral health education school program for students and their families to understand the importance of adequate oral hygiene and regular dental appointments.[26]

Conclusion

Under the limitation of this study, we concluded that, with the exception of Ketac Molar Easymix, resin-based sealants performed better than glass ionomer-based sealants. The retention rate of all materials was decreased by the time. Further studies are required in this field with prolonged observational time.

Clinical Significance

- Proper application of pit and fissure sealant will decrease the chance for caries development in newly erupted teeth.

- A resin-based sealer performs better than a glass ionomer-based sealer.
- An unfilled resin sealer retains for a longer period than a filled resin sealer.

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