

One-year Clinical Evaluation of Retention Ability and Anticaries Effect of a Glass Ionomer-based and a Resin-based Fissure Sealant on Permanent First Molars: An *In Vivo* Study

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ABSTRACT

Aim: To evaluate and compare the retention ability, anticaries effect and marginal discoloration when sealed with a glass ionomer-based sealant (Fusion i-seal) and a resin-based fissure sealant (Helioseal-F) on permanent first molars.

Materials and methods: Caries free, fully erupted permanent first molars of 50 children between 6 years and 8 years were sealed with pit and fissure sealants under rubber dam isolation. Glass ionomer-based sealant was applied on a permanent first molar and the contralateral molar with resin-based sealant. The sealants were evaluated at regular intervals for a period of 1 year. Statistical analysis was done by Chi-square test.

Results: Higher retention rates were noted for resin-based sealant (88%) compared to glass ionomer-based sealant (78%). None of the teeth sealed with resin sealant developed caries whereas 2% of teeth sealed with glass ionomer sealant developed caries. Marginal discoloration was not noted in teeth sealed with glass ionomer sealant whereas slight marginal discoloration was noted for 6% of teeth sealed with resin sealant.

Conclusion: Clinically a difference was noted in the retention rate, anticaries effect and marginal discoloration whereas statistically no significant difference was noted for the two sealants after 1 year.

Clinical significance: Pit and fissure sealants are highly effective and economical in preventing occlusal caries in young permanent tooth with low failure rate.

Keywords: Anticaries effect, Fissure sealant, Marginal discoloration, Retention.

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INTRODUCTION

Dental caries is a preventable disease of the mineralized tissues of the teeth with a multifactorial etiology. Over the last few decades, several advancements have been made in caries prevention. Fluorides are found to be extremely effective in preventing caries on the smooth surfaces but less effective on the occlusal surfaces. Pit and fissure sealants are highly effective in preventing occlusal caries on permanent posterior teeth by forming a barrier between the tooth and oral environment.

The complex morphology of the occlusal pits and fissures favors the retention of bacteria and food remnants, rendering proper oral hygiene maintenance difficult. Lack of salivary access into the fissures also reduces the fluoride effectiveness at this spot. The technique of pit and fissure sealants plays undoubtedly a fundamental role in preventing occlusal caries both in primary and permanent teeth.¹

Probably, the most caries susceptible period of first permanent molar is the long eruption phase as the enamel is immature during this period.² Sealant application is highly effective in preventing occlusal caries during this period. About 71% of occlusal decay is preventable after one-off sealant application.³ Newer technologies and the development of pit and fissure sealants have shifted the treatment philosophy from "drill and fill" to that of "seal and heal".

While pit and fissure sealants have been demonstrated to be effective in occlusal caries prevention, incorrect application of the sealant could result in microleakage, larger restorations, endodontic treatment, sealant loss and failure. Therefore, regular follow-up is required to ensure long-term success of the sealant treatment.⁴

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Commonly used fissure sealants in pediatric dentistry include the sealants which chemically bond to the tooth (glass ionomer-based sealants) and which micromechanically bond to the tooth (resin-based sealants). Glass ionomer sealants exhibit good anticaries properties due to their fluoride release but their retention on long-term basis is less due to decreased wear resistance. Fusion i-seal is a newer light cured glass ionomer-based sealant which is expected to have better wear resistance and adhesion than conventional glass ionomer sealant. Resin-based sealants have good retention but their anticaries properties are lost once the sealant material is lost from the tooth.

The present study evaluated the retention and anticaries property of a glass ionomer-based sealant (Fusion i-seal) and was

compared with the retention and anticaries properties of a resin-based fissure sealant (Helioseal-F).

MATERIALS AND METHODS

The study was carried out among 50 children of 6–8 years who were reported in the Department of Pedodontics and Preventive Dentistry, Government Dental College, Kozhikode for routine dental treatment. Approval from the Institutional Ethics Committee, Govt. Medical College, Kozhikode and parent consent was obtained prior to the commencement of the study.

Inclusion Criteria

- Healthy children of 6–8 years.
- Completely erupted and caries free permanent first molars with deep pits and fissures.

Exclusion Criteria

- The children whose parents didn't give the informed consent.
- Medically compromised and special children.
- History of adverse reaction to any restorative materials.

Methods

The two permanent first molars of every child were randomly assigned into 2 groups.

Group I: Sealed with Fusion i-seal (Prevest DenPro Limited, Jammu, India)

Group II: Sealed with Helioseal-F (Ivoclar Vivadent, Newyork, USA)

After prophylaxis and polishing, two fissure sealants were randomly placed in 50 matched contralateral pairs of permanent molars under rubber dam isolation based on manufacturer's instructions.

In both the cases enamel was etched with 37% ortho phosphoric acid for 30 seconds, washed and dried. Sealant was placed to cover the entire pit and fissures; excess material was removed and light cured. Occlusion was checked with an articulating paper and premature contacts were relieved.

Children were instructed not to eat or drink anything for at least 1 hour after the procedure and to maintain good oral hygiene.

Clinical Evaluation

At 3rd, 6th and 12th months interval evaluation was done for:

- Retention of the sealant.
- Development of caries.
- Marginal discoloration of the sealed tooth.

Retention of the Sealant

Retention was clinically evaluated using a mouth mirror and probe using modified Simonsen's criteria:⁵

Score 0: No loss of sealant and no evidence of caries.

Score 1: Partial loss of sealant and no evidence of caries.

Score 2: Partial loss of sealant and evidence of caries.

Score 3: Complete loss of sealant and no evidence of caries.

Score 4: Complete loss of sealant with caries evidence.

Development of Caries

Caries development on the occlusal surfaces of the tooth was evaluated by visual inspection and modified Simonsen's criteria.

Marginal discoloration of the sealed tooth.

Marginal discoloration was evaluated using visual inspection and scored.

Score 0: No marginal discoloration.

Score 1: Marginal discoloration.

RESULTS

The data were obtained at 3rd, 6th and 12th months intervals. The results were tabulated for retention, development of caries and marginal discoloration and stastically compared using Chi-square test of significance.

Retention of the Sealant

Higher retention rates were noted for resin-based sealant 88% compared to glass ionomer-based sealant 78% (Table 1). The Chi square value at 3rd, 6th and 12th month interval for retention was 1.76, 3.63 and 5.30 respectively and the corresponding p value was 0.41, 0.16 and 0.15 which means no statistically significant difference for retention for two tested groups in given time period (Table 2).

Development of Caries

None of the teeth sealed with resin sealant developed caries whereas 2% of teeth sealed with glass ionomer sealant developed caries (Table 3). The Chi square value at 12th month interval was 1.01 and the corresponding p value was 0.32. The p value for development of caries was not significant for the two groups tested (Table 4).

Marginal Discoloration of the Sealed Tooth

Marginal discoloration was not noted in teeth sealed with glass ionomer sealant whereas slight marginal discoloration was noted for 6% of teeth sealed with resin sealant (Table 5). The Chi square value at 6th and 12th months interval was 1.01 and 3.09 respectively and the corresponding p value was 0.32 and 0.08 which means that there was no statistically significant difference for development of marginal discoloration of sealed tooth (Table 5).

DISCUSSION

Pit and fissure sealants are an important part of caries preventive strategies. The rationale for the use of sealants as a preventive intervention is the high prevalence of pit and fissure caries. When applied to deep, caries prone pit and fissures they form a seal which prevent the nutrients from reaching the microflora in the fissures leading to a decrease in the count of microflora or their elimination. The caries preventive effects of the sealants are maintained only as long as it remains completely intact and bonded in place.

Two basic types of sealants used currently include glass ionomer-based sealants and resin-based sealants. Resin-based sealants are more commonly used because of their high retention rates but their placement is very technique sensitive and are extremely sensitivity towards moisture due to the presence of hydrophobic Bis-GMA material.

Glass ionomer sealants are less sensitive to moisture, release fluoride and adhere to enamel but are inadequately retained due to low wear resistance.

This study evaluated and compared retention ability, anticaries effect and marginal discoloration when sealed with a glass ionomer-based fissure sealant and a resin-based fissure sealants on permanent first molars (Figs 1 to 3).

In the present study permanent first molars of 6–8-year-old children were selected for the application of pit and fissure sealants.

Table 1: Comparison of retention of Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval

Retention		3rd month		6th month		12th month	
		Fusion i-seal	Helioseal-F	Fusion i-seal	Helioseal-F	Fusion i-seal	Helioseal-F
Total retention	Count	45	48	40	45	39	44
	%	90	96	80	90	78	88
Partial retention	Count	4	2	7	5	7	6
	%	8	4	14	10	14	12
Total loss	Count	1	0	3	0	4	0
	%	2	0	6	0	8	0

Table 2: Comparison of retention of Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval (modified Simonsen's scoring)

Study period	Modified Simonsen's scoring for retention	Group				Chi-square	p value
		Fusion i-seal		Helioseal-F			
		Count	Column n %	Count	Column n %		
3rd month	Score 0: No loss of sealant and no evidence of caries	45	90.00	48	96.00	1.76	0.41
	Score 1: Partial loss of sealant and no evidence of caries	4	8.00	2	4.00		
	Score 2: Partial loss of sealant and evidence of caries	0	0.00	0	0.00		
	Score 3: Complete loss of sealant and no evidence of caries	1	2.00	0	0.00		
	Score 4: Complete loss of sealant and evidence of caries	0	0.00	0	0.00		
6th month	Score 0: No loss of sealant and no evidence of caries	40	80.00	45	90.00	3.63	0.16
	Score 1: Partial loss of sealant and no evidence of caries	7	14.00	5	10.00		
	Score 2: Partial loss of sealant and evidence of caries	0	0.00	0	0.00		
	Score 3: Complete loss of sealant and no evidence of caries	3	6.00	0	0.00		
	Score 4: Complete loss of sealant and evidence of caries	0	0.00	0	0.00		
12th month	Score 0: No loss of sealant and no evidence of caries	39	78.00	44	88.00	5.30	0.15
	Score 1: Partial loss of sealant and no evidence of caries	6	12.00	6	12.00		
	Score 2: Partial loss of sealant and evidence of caries	1	2.00	0	0.00		
	Score 3: Complete loss of sealant and no evidence of caries	4	8.00	0	0.00		
	Score 4: Complete loss of sealant and evidence of caries	0	0.00	0	0.00		

Table 3: Comparison of caries development status of teeth sealed with Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval

Caries developed		3rd month		6th month		12th month	
		Fusion i-seal	Helioseal-F	Fusion i-seal	Helioseal-F	Fusion i-seal	Helioseal-F
Present	Count	0	0	0	0	1	0
	%	0	0	0	0	2	0
Absent	Count	50	50	50	50	49	50
	%	100	100	100	100	98	100

Even though pit and fissure surface accounts for only 13% of total tooth surface about 80% of dental caries in children occurs in these site.⁶ To obtain maximum benefit from sealant application sealants

should be applied at the earliest possible time after their eruption when the enamel lining is porous and the fissures are rich in cellular and organic debris.

Table 4: Comparison of caries development status of teeth sealed with Fusion i-seal and HeliOSEAL-F at 3rd, 6th and 12th month interval (modified Simonsen's scoring)

Study period	Caries development status (modified Simonsen's scoring)	Group				Chi-square	p value
		Fusion i-seal		HeliOSEAL-F			
		Count	Column n %	Count	Column n %		
3rd month	Score 0: No loss of sealant and no evidence of caries	50	100.00	50	100.00	—	—
	Score 1: Partial loss of sealant and no evidence of caries	0	0.00	0	0.00		
	Score 2: Partial loss of sealant and evidence of caries	0	0.00	0	0.00		
	Score 3: Complete loss of sealant and no evidence of caries	0	0.00	0	0.00		
	Score 4: Complete loss of sealant and evidence of caries	0	0.00	0	0.00		
6th month	Score 0: No loss of sealant and no evidence of caries	50	100.00	50	100.00	.	.
	Score 1: Partial loss of sealant and no evidence of caries	0	0.00	0	0.00		
	Score 2: Partial loss of sealant and evidence of caries	0	0.00	0	0.00		
	Score 3: Complete loss of sealant and no evidence of caries	0	0.00	0	0.00		
	Score 4: Complete loss of sealant and evidence of caries	0	0.00	0	0.00		
12th month	Score 0: No loss of sealant and no evidence of caries	49	98.00	50	100.00	1.01	0.32
	Score 1: Partial loss of sealant and no evidence of caries	0	0.00	0	0.00		
	Score 2: Partial loss of sealant and evidence of caries	1	2.00	0	0.00		
	Score 3: Complete loss of sealant and no evidence of caries	0	0.00	0	0.00		
	Score 4: Complete loss of sealant and evidence of caries	0	0.00	0	0.00		

Table 5: Comparison of marginal discoloration status of teeth sealed with Fusion i-seal and HeliOSEAL-F at 3rd, 6th and 12th month interval

Study period	Marginal discoloration	Group				Chi-square	p value
		Fusion i-seal		HeliOSEAL-F			
		Count	%	Count	%		
3rd month	No marginal discoloration	50	100.00	50	100.00	—	—
	Marginal discoloration	0	0.00	0	0.00		
6th month	No marginal discoloration	50	100.00	49	98.00	1.01	0.32
	Marginal discoloration	0	0.00	1	2.00		
12th month	No marginal discoloration	50	100.00	47	94.00	3.09	0.08
	Marginal discoloration	0	0.00	3	6.00		

For better penetration of sealants, the tooth surface should be cleaned prior to the sealant application. In the present study, prior to the sealant application tooth surface was cleaned using pumice, water and prophyl cups but mechanical widening of the fissures was not carried out. Welbury et al.⁷ in the EAPD guidelines for the use of pit and fissure sealants suggested that the removal of most organic substance is required to obtain sufficient bonding of sealant to the tooth and the removal of sound tooth tissue by the use of instruments such as bur is unnecessary and undesirable.

Adequate isolation is the most important step in sealant application. Salivary contamination is the major cause of sealant loss in the first year.⁸ Rubber dam when placed properly provides the best isolation and might be a reason for increased sealant retention in the present study. Similar findings were reported by Ganss et al.⁹ where the sealant retention and sealant quality was improved when placed under rubber dam.

Sealants used in the present study include a glass ionomer based sealant (Fusion i-seal) and a resin-based sealant (HeliOSEAL-F). Even though the Fusion i-seal can be placed with and without acid



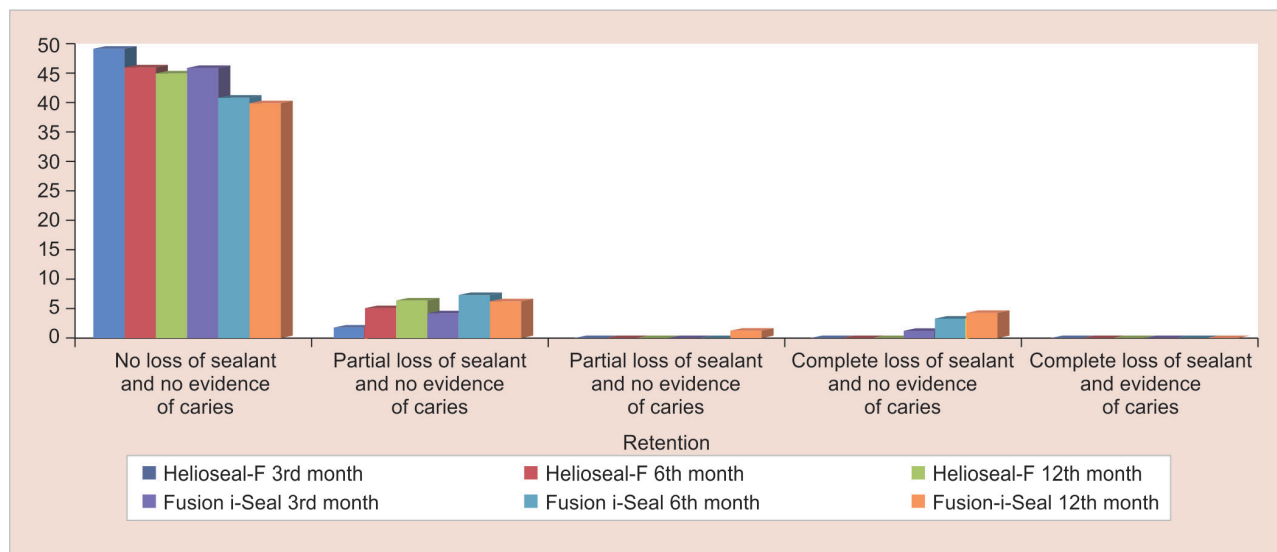


Fig. 1: Comparison of retention of Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval [modified Simonsen's scoring (graphical representation)]

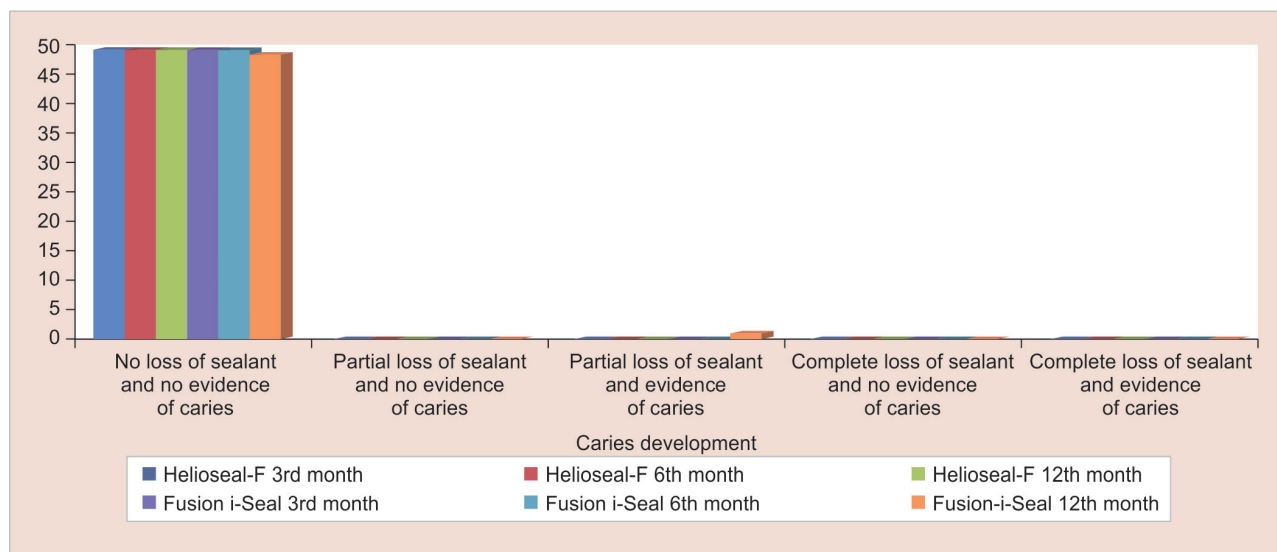


Fig. 2: Comparison of caries development status of Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval [modified Simonsen's scoring (graphical representation)]

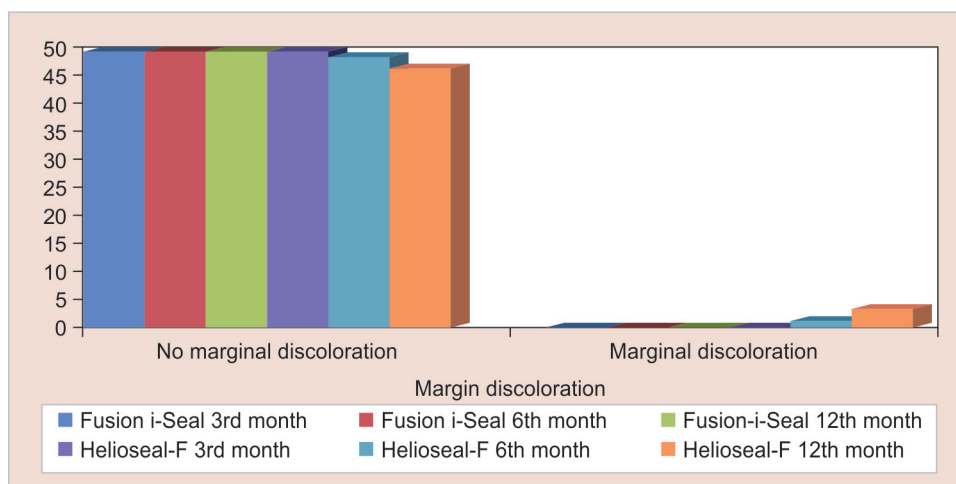


Fig. 3: Comparison of marginal discoloration status of teeth sealed with Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval (graphical representation)

etching, the tooth surface was etched with 37% orthophosphoric acid to produce better penetration of the sealant material.

In the present study the retention rate (complete retention) of Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month interval was 90%, 80%, 78% and 96%, 90%, 88%, respectively. Even though clinically the retention rate was higher for resin sealant at 3rd, 6th and 12th months interval statistically no significant differences were noted. Similar high retention rates were reported for glass ionomer sealants by Torppa-Saarinen and Seppa¹⁰ and Kamala and Hedge¹¹ which is in accordance with the present study.

Torppa-Saarinen and Seppa¹⁰ reported high retention rate for Fuji III when placed on newly erupted molars and premolars. After four months, 75% of the sealants were completely retained and 22% partially retained. Kamala and Hedge¹¹ reported 80% (complete/partial) retention for Fuji III and Fuji VII after 1 year.

Studies have showed that conventional glass ionomer sealants had poor retention rates but modified glass ionomers like resin modified glass ionomer exhibit better retention. So, in the present study a newer light cured glass ionomer sealant (Fusion i-seal) was used. The main component of Fusion i-seal is glass ionomer filler, polyacrylic acid, methacrylated polycarbonic acid, barium glass filler and Bis-GMA. They exhibit better adhesion to tooth and allows controlled expansion to compensate for curing contraction of composite material and can be used with and without acid etching. These properties have also contributed to the high retention rate of glass ionomer sealant in the present study.

Routine clinical use of glass ionomer sealant is unreliable because of their poor retention and retention rate varies from 2% to 93% after 6 months. One of the main reasons for the early loss of the glass ionomer sealants could be inadequate adhesion to the tooth. Exposure of the cement to saliva before complete setting may predispose to surface degradation and early loss of the sealant. The good retention rate of glass ionomer sealants in the present study 78% complete retention and 16% partial retention after 1 year may be attributed to the use of proper technique (rubber dam isolation, acid etching) and high wear resistance and better adhesion property of Fusion i-seal.

Most of the studies reported high retention rates for resin sealants. In the current study complete retention for resin sealant (Helioseal-F) at 3rd, 6th and 12th months interval was 96%, 90%, 88%, respectively. Similar high retention rates were reported for resin sealants in the studies conducted by Skrinjaric et al., Ugur et al., Shashikiran et al., Lygidakis et al. and Oliveira et al. They reported complete retention of Helioseal-F after 1 year was 80.4% (Skrinjaric et al.)¹² and 94.8% (Ugur and Hande).¹³ Shashikiran and Subbareddy¹⁴ reported 84.6% of complete resin sealant retention after 10 months. Lygidakis et al.¹⁵ observed complete retention rate of 70.2% after 4 years and Oliveira et al.¹⁶ reported 79% retention rate for resin sealants after 1 year.

On the other hand, low retention rates were also reported for resin sealants in some studies. Subramaniam et al.² and Bhatia et al.¹⁷ reported 14.6% and 17.6% complete retention of resin sealants respectively after 1 year. The reasons for poor retention of sealants may be inadequate moisture control, incomplete sealing of fissures, inadequate etching, rinsing and drying and inadequate curing time.

Studies have showed that both the glass ionomer and resin sealants exhibit good retention when placed under ideal conditions using good placement techniques.

Success of a pit and fissure sealant depends largely on its anticaries effect. Caries increment is low when the sealants are

fully retained on the tooth.¹ Caries preventive effect of glass ionomer sealants depends on both retention and fluoride release. The anticaries effect of resin sealant depends on its full retention on the tooth and their anticaries effect is lost once the material is lost from the tooth surface but the fluoride releasing resin sealants exhibit better anticaries effect due to their slow fluoride releasing property. Partial retention of sealant is considered as failure as it leaves the tooth equally susceptible to caries as an unsealed tooth.¹⁸

Charbeneau and Dennison¹⁹ reported that the complete loss of sealant does not appear to predispose the tooth surface to caries but the partial loss of sealants results in the exposure of the terminal ends of fissure and creates an environment conducive to caries. In contrary to this partial loss of the sealant it may be considered as success when they release fluoride and exert an anticaries effect on the adjacent tooth structure. So, they suggested periodic clinical observation to determine the success of the sealant treatment.

The current study measured the effectiveness of the sealant by its ability to prevent caries in the sealed surfaces of permanent first molars in children considered to be at high risk for developing pit and fissure caries. Caries development was noted in 2% of teeth sealed with Fusion i-seal whereas none of the tooth sealed with Helioseal-F developed caries. No statistically significant difference was seen in caries development between the two groups at 3rd, 6th and 12th months interval.

Even though glass ionomer sealants are known for their fluoride release and anticaries effect similar to the results of present study caries development was noted more in glass ionomer sealant than resin sealant in studies by Poulsen et al.²⁰ and Skrinjaric et al.¹² Poulsen et al.²⁰ reported that 3 years after the placement, glass ionomer sealant was completely lost in almost 90% whereas less than 10% of the sealant was lost in resin sealed tooth. The relative caries risk of tooth sealed with glass ionomer over that of a tooth sealed with resin was 3.38%.

On the other hand, Antonson et al. reported better anticaries effect for glass ionomer sealant compared to resin sealant. Antonson et al.²¹ reported that even though 59.3% of glass ionomer sealant was lost after 2 years none of them developed caries whereas the teeth sealed with resin-based sealant exhibit demineralization.

In the present study better anticaries effect of Helioseal-F was due to their increased retention and fluoride releasing property. Fissure sealing is an effective method to prevent caries development and had a low failure rate. Pit and fissure sealants applied during the childhood will have a long-lasting caries preventive effect if properly applied and regularly monitored.

Marginal discoloration of the tooth adjacent to the sealant can be considered as an early indicator of loss of marginal integrity of the sealant. Sealed tooth discolors at its margins when there is marginal breakdown of sealant which providing a niche for the plaque accumulation leading to secondary caries.¹

In the present study, marginal discoloration was checked visually with the help of a mouth mirror. At the baseline, all the sealants were checked visually and scored no cavosurface marginal discoloration. None of the teeth sealed with Fusion i-seal developed marginal discoloration at 3rd, 6th and 12th months intervals. Two percent (1 tooth) of teeth sealed with Helioseal-F developed marginal discoloration at 6th month recall interval which gradually increased to 6% (3 teeth) at the end of 12th month. The cavosurface marginal discoloration of Fusion i-seal and Helioseal-F at 3rd, 6th and 12th month was not statistically significant.

CONCLUSION

The present study showed that there was no statistically significant difference in the retention rate, anticaries effect and marginal discoloration for newer glass ionomer-based sealant (Fusion i-seal) and resin-based sealant (Helioseal-F).

Further studies should be conducted for a longer duration with larger samples and more advanced materials to derive a conclusion regarding the retention, anticaries effect and marginal discoloration when these sealants were used.

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