

Soft-Start Polymerization of Fissure Sealant: Retention after Three Years

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ABSTRACT

The aim of this study was to investigate retention of composite fissure sealant polymerized with standard and soft-start technique after a three year clinical trial. One hundred teeth were divided into two groups (A&B) of teeth and sealed with composite material (Visioseal, 3M Espe) using split mouth design. Sealants were polymerized using standard (Group A) and soft-start (Group B) techniques with commercial polymerization unit (Elipar Highlight, 3M Espe). Retention rate in Group A was 72%. In 14 teeth sealant was partially or completely missing. Group B showed retention rate of 80%. Sealant was partially or completely missing in 10 teeth. Six new caries lesions in Group A (3) and B (3) were detected. Mann-Whitney test did not reveal significant differences between the polymerization techniques. After three years complete retention of sealants, regardless of the group, was 76% (76 teeth) with six new caries lesions. Soft-start polymerization showed a comparable retention rate as the standard polymerization technique.

Key words: fissure sealants, soft-start polymerization, sealant retention rate

Introduction

In order to achieve maximum caries preventive effect there must be perfect adhesion of the sealant material to tooth enamel. Perfect adhesion of the material should be maintained not only while setting but also during function (including challenge of thermal and mechanical cycling). Complete retention of sealant material in the fissures ensures good adhesion to enamel. Studies conducted by Feigal (1998), Llodra et al. (1993), Heidman et al. (1990) and Wendt et al. showed good caries prevention effect if retention of sealant in the occlusal surfaces is achieved¹⁻⁴.

Polymerization shrinkage and consequently development of shrinkage stress is the main problem associated with the curing of composite dental materials. As a result of this phenomenon debonding of the curing material from the dental tissues occurs, enabling the occurrence of marginal gaps⁵⁻⁸. Because of the morphology of occlusal surfaces calculation of the configuration factor value (so called C factor) for occlusal surfaces is very difficult. However, even very imprecise calculation of bonded and

unbonded occlusal surfaces gives a result of more than 5, which means development of maximum shrinkage stress⁹. The main clinical problems associated with gap formation are microleakage of fluids, bacteria and debris, creating secondary caries lesions and possible pulpal pathology.

There are several methods proposed in the literature to compensate polymerization shrinkage stress and minimize the deteriorating effect of marginal gaps. One of the proposed methods is by varying the time and intensity of illumination during polymerization of the composite material, so-called SOFT-START polymerization^{10,11}.

The general idea of Soft-start polymerization technique is to enable prolonged flow of curing material (in the pre-gel phase) by using low intensity light during the first 10 s of polymerization, allowing the molecules in the material to rearrange and create quality adhesion to dental tissue. Several combinations of light intensity and illumination times have been proposed in order to achieve

the best material properties and to minimise material dimensional changes^{12–14}.

The aim of this study was to analyse the retention rate of dental sealants polymerized with standard and soft-start polymerization techniques after 3 years of clinical service.

Materials and Methods

The study was performed on 100 teeth (65 patients, 7–12 years old); first and second molars, with well delineated fissure morphology, divided into two groups of 50 using split mouth design. The procedures, possible discomfort or risk, as well as possible benefits were explained fully to the parents, and their informed consent was obtained prior to the investigation. The study was approved by the Ethics Committee of the University of Zagreb, School of Dental medicine.

Teeth were sealed with composite sealant material Visioseal (3M ESPE). Isolation of teeth prior to the sealant placement was secured using cotton rolls. One of tooth in the pair was polymerized with standard and another with soft start method. Teeth on the left side of the mouth were polymerized using soft start while teeth on the right side were polymerized with standard method. The method of application of the sealant material was carried out in accordance with the manufacturer’s recommendations, which included enamel etching with phosphoric acid for 20 s, 20 s rinsing with water and 20 s drying of the occlusal surface. Polymerization of sealants was performed by the commercially available unit Elipar Highlight (3M ESPE) with integrated different modes of polymerization. Protocol for soft start method was set by the manufacturer in the following way: 10 s illumination with intensity of 200 mW/cm² following 30 s with intensity of 800 mW/cm². Standard polymerization was 40 s with light intensity of 800 mW/cm². Evaluation of sealant retention was performed using the method proposed by Kilpatrick et al.¹⁵ as follows: 1 – intact sealant; 2 – 1/3 of sealant missing; 3 – 2/3 of sealant missing; 4 – whole sealant missing. Presence of new caries lesions was evaluated in two categories: 1 – absent, 2 – present. The obtained data were analysed using non-parametric Mann-Whitney U test. Mann-Whitney U test is a non-parametric alternative to t-test for independent samples and uses

coding variable (independent variable) for analysis. It is also suitable for small samples and for samples larger than 20 sampling distribution approaches to normal distribution.

Results

After three years of clinical service complete retention of sealants polymerized with soft-start method was observed in 40 teeth (80%) while sealants were partially missing in 5 teeth (10%) and completely missing in 5 teeth (10%). In the group polymerized with standard method complete retention was noted in 36 teeth (72%) and the sealants were partially and completely missing in 14 teeth (28%). Mann-Whitney test did not reveal significant difference in retention between the polymerization methods (Table 1). Incidence of new caries lesions after three years in the group of teeth polymerized with soft start method was 3 (6%) as well as in the group polymerized with standard method. Also, with regard to caries incidence Mann-Whitney test did not reveal significant statistical difference between the polymerization methods (Table 2). Distribution of sealed teeth in the upper and lower jaws were as follows: 48 pairs in the maxilla with complete retention rate of 72.9%, and 52 pairs in the mandible with complete retention of 78.8% (Table 3). There was no significant difference between the upper and lower jaw regarding retention. New caries lesions incidence was the same in the maxilla and mandible, 3 (6.2%) with no significant statistical difference (Table 4). Generally, complete retention of Visioseal sealant

TABLE 2
INCIDENCE OF NEW CARIES LESIONS AFTER THREE YEARS

Technique of polymerization	Incidence of new caries lesions after 3 years			Mann-Whitney (p)
	1	2	Total	
Standard	47	3	50	1.0 (ns)
%	94	6	100	
Soft-start	47	3	50	1.0 (ns)
%	94	6	100	
Total	94	6	100	

p>0.05, ns – not significant

TABLE 1
SEALANT RETENTION RATE AFTER THREE YEARS

Technique of polymerization	Sealant retention after 3 years					Mann-Whitney (p)
	1	2	3	4	Total	
Standard	36	10	2	2	50	0.46 (ns)
%	72	20	4	4	100	
Soft-start	40	5	0	5	50	0.46 (ns)
%	80	10	0	10	100	
Total	76	15	2	7	100	

p>0.05, ns – not significant

TABLE 3
RETENTION OF SEALANTS IN THE UPPER AND LOWER JAW

Location of sealant	Sealant retention after 3 years					Mann-Whitney (p)
	1	2	3	4	Total	
Maxilla	35	8	1	4	48	0.48 (ns)
%	72.9	16.7	2.1	8.3	100	
Mandible	41	7	1	3	52	
%	78.8	13.5	1.9	5.8	100	
Total	76	15	2	7	100	

p>0.05, ns – not significant

TABLE 4
INCIDENCE OF NEW CARIES LESIONS IN THE UPPER AND LOWER JAW

Location of sealant	Incidence of new caries lesions after 3 years			Mann-Whitney (p)
	1	2	Total	
Maxilla	45	3	48	0.91 (ns)
%	93.8	6.2	100	
Mandible	49	3	52	
%	94.2	5.8	100	
Total	94	6	100	

p>0.05, ns – not significant

material after three years of clinical service was 76%, regardless of the polymerization technique.

Discussion

Reduced caries incidence noted in previous studies showed that retention rate is directly connected with the preventive effect^{4,16–18}. Obtained results in the present study regarding retention rate were in accordance with other studies. Rock et al.¹⁶ showed for FluroShield 70% retention after three years, with significantly better performance on lower molars. The same author¹⁹ noted 77% retention after three years for light cured sealants that was better compared to chemically cured sealants. Raadal et al.²⁰ obtained very high values of retention after three years of 97%, and Eidelman et al.²¹ also reported high values of 91%, proving that 20s etching time is just as efficient as 60s. A study performed by Lygidakis et al.²² showed retention rate after four years between 81–93% with no significant statistical difference between cotton roll isolation and rubber dam method. They also noted better retention of sealant in lower molars than in upper molars with the explanation that material flowing distally in the upper molar leaves only a thin layer of material susceptible to fracture. In the present study the same result was obtained although not statistically significant. One of the reasons could be visibility problems in the upper distal (first or second molars) teeth combined with technical sensitivity of the procedure. Al-

though not significant the retention rate of sealants polymerized with soft start method was better than the retention rate after standard polymerization. There are several elements that must be taken into consideration. According to studies by Labella et al.²³ and Price et al.²⁴, polymerization shrinkage of unfilled resin can amount to 11% which is 3–4 times more compared to composite materials. Prolonged flow for compensation of polymerization shrinkage can be of great importance for the sealant material. Thickness of the sealant material applied in the fissures also can influence polymerization shrinkage. In their study Alster et al.⁵ showed increased values of contraction stress for very thin (50–200 µm) composite samples. Thickness of the sealant material applied on an uneven occlusal surface is not uniform in all parts of the pits and fissures, leading to different polymerization contraction stress. Additionally, configuration factor (C factor) defined as the relation of bonded and unbonded surfaces²⁵ is very difficult to calculate and even imprecise calculation provides value of more than 5, which means development of maximal shrinkage stress. The results obtained in retention rate using soft start polymerization method corroborate results obtained in studies on filled composite materials^{26–30}. Prolonged pre-gel phase and rearrangement of polymer chains in sealant material during setting creates better adaptation of sealant material to tooth enamel. Also, shrinkage directed to bonded surfaces, as shown by Versluis et al.³¹, can influence retention and formation of marginal gaps. However, one should be very cautious in interpretation of the results, because of other factors that can influence retention such as occlusion, diet (food consistency), hygiene etc. A study by Fleming et al.³² showed no significant statistical difference in cuspal movement of premolar teeth or microleakage after polymerization of composite restoration material with soft-start technique compared to standard polymerization. Emerging on the market are new polymerization devices such as LED polymerization units and plasma units, as well as very high intensity halogen light units, which may improve the retention rate of dental sealants. According to Visvanathan et al.³³ soft start mode is not as efficient in LED polymerization units although they enable prolonged gel phase of the material during polymerization. Also the technique of applying sealants can influence the retention rate, and this will probably be the objective of further investigations.

Conclusion

On the basis of the obtained results it is possible to draw the following conclusions:

1. Retention rate of sealants polymerized with soft start polymerization method was very similar to the stan-

dard polymerization technique and no statistically significant differences were observed.

2. Both polymerization techniques can be considered of equal value and can be used in clinical practice.

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PEČAĆENJE FISURA PRIMJENOM SOFT-START POLIMERIZACIJE: RETENCIJA NAKON 3 GODINE

SAŽETAK

Svrha ovog istraživanja bila je evaluacija stupnja retencije kompozitne pečatne smole polimerizirane standardnom i soft-start tehnikom polimerizacije nakon tri godine kliničke primjene. Stotinu zuba podijeljenih u dvije skupine (A&B) pečaćeno je kompozitnom pečatnom smolom (Visioseal, 3M Espe). Pečatna smola polimerizirana je primjenom standardne (skupina A) i soft-start (skupina B) tehnike upotrebom polimerizacijske lampe (Elipar Highlight, 3M Espe). Stupanj retencije pečata u skupini A bio je 72%. U 14 zuba pečat je djelomično ili potpuno nedostajao. U skupini B stupanj retencije bio je 80%. Materijal za pečaćenje je djelomično ili potpuno nedostajao u 10 zuba. Ustanovljeno je šest novih karijesnih lezija, tri u skupini A i tri u skupini B. Za statističku analizu korišten je Mann-Whitney test. Nije ustanovljena statistički značajna razlika u stupnju retencije između tehnika polimerizacije. Potpuna retencija materijala za pečaćenje u obje skupine nakon tri godine bila je 76% (u 76 zuba) uz šest novih karijesnih lezija. Ustanovljen je usporediv stupanj retencije između standardne i soft-start tehnike polimerizacije.