Plaque and Saliva Fluoride Levels After Placement of Fluoride Releasing Pit and Fissure Sealants

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Abstract

Purpose: The objectives of this study were to investigate the fluoride levels in plaque and saliva before and after applying fluoride-containing pit and fissure sealants, and compare the fluoride release of 2 types of sealants at the different time intervals.

Methods: Eighteen children ages 6 to 9 years were randomly divided into 2 groups: Group 1—sealant containing fluorosilicate glass (Helioseal-F); and group 2—sealant containing methacryloyl fluoride-methyl methacrylate copolymer (Teethmate-F). Saliva and plaque samples were collected before and after the sealants were placed on their 4 first permanent molars. Fluoride levels were determined using the microdiffusion method. Fluoride concentrations before and after placing the sealants were analyzed by paired *t* test, and the fluoride concentrations between the 2 sealants were compared by *t* test, with the level of significance at 0.05.

Results: There was no significant difference between salivary fluoride levels before and after sealant placement application in both groups. The plaque fluoride level of Helioseal-F group at 24 hours was significantly higher than the baseline level (P=.03), and was not different afterwards. The plaque fluoride levels after sealant with Teethmate-F were not significantly different when compared to the baseline. However, there were no significant differences between salivary and plaque fluoride levels of the 2 groups at different time intervals.

Conclusions: The groups sealed with sealant containing fluorosilicate glass showed significant increase of plaque fluoride level only at 24 hours after sealant placement. (*Pediatr Dent*. 2004;26:63-66)

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Fluoride and pit and fissure sealants, have been widely accepted and well documented as effective caries prevention measures.[1-3] Fluoride works primarily via topical mechanisms including inhibition of demineralization, enhancement of remineralization at the crystal surfaces, and inhibition of bacterial enzymes.[4] A low but slightly elevated level of fluoride in saliva and plaque helps to prevent and reverse caries by inhibiting demineralization and enhancing remineralization.[5,6] Fluoride concentration as low as 0.02-0.06 ppm has been shown to enhance remineralization when enamel specimens were subjected to in vitro demineralization.[6] In addition, slow release of fluoride from restorative materials or a specially designed slow-release device has also been shown to induce remineralization and hypermineralization of dentin.[7,8] For these reasons, fluoride compounds have been incorporated into several kinds of dental materials, including pit and fissure sealants, with the expectation of caries-inhibition on the tooth surface adjacent to the materials.[9-16]

Currently, 2 methods of fluoride incorporated into pit and fissure sealants are used. The first type, soluble fluoride salts (sodium fluoride, acidulated sodium fluoride, and sodium monofluorophosphate) and fluorosilicate glass, are added to unpolymerized resin. The release of fluoride is via

the diffusion of water into the hydrophobic matrix. The water dissolves the hydrophilic fluoride ion, then diffuses out of the matrix into the surrounding environment.[17,18] In the second type, organic fluoride compound is chemically bound to a resin, such as methacryloyl fluoride, which is covalently bound to methyl methacrylate—forming methacryloyl fluoride-methyl methacrylate copolymer (MF-MMA). Fluoride in this compound presents in an acidic form covalently bonded to carbonyl groups. The fluoride ions are slowly released by hydrolysis in aqueous solution.[17] This material was claimed to be a long-term-fluoride-release-type material.[19]

An in vitro study of Helioseal-F, which contains fluorosilicate glass, showed that the profile of fluoride release was greatest within the first 24 hours (1.682±0.223 ppm), then fell sharply on the second day (0.579±0.094 ppm), and gradually decreased until the 30th day (0.081±0.009 ppm).[20] The sealant containing methacryloyl fluoride-methyl methacrylate (MF-MMA), Teethmate-F, was found to release a higher amount of fluoride from the first 24 hours (2.095±0.251 ppm) to the second day (0.831±0.169 ppm) until day 30 (0.242±0.016 ppm).[20] However, these investigations were in vitro, and there was no report on in vivo study.

The objectives of this study were to investigate the fluoride level in plaque and saliva before and after applying fluoride-containing pit and fissure sealants, and compare the fluoride release of 2 types of sealants at the different time intervals.

Materials and Methods

Subject selection

Eighteen children ages 6 to 9 years with cooperative behavior—all from a school which receives dental care from a local public health center—were selected to enroll in the study. These children routinely receive professional topical fluoride every 6 months, and each child's 4 caries-free first permanent molars are sealed when they are in first grade. Their parents reported that they did not get fluoride supplements, and fluoride gel application was not scheduled during the study period. The parents were asked to stop using fluoride toothpaste and were provided with commercially available nonfluoridated toothpaste (Saltz, Lion, Thailand). Informed consent stating the procedures of the study was signed. The dmft, dmfs, and baseline salivary pH of all subjects were recorded.

The subjects were randomly divided into 2 groups: group 1 (N=9) were applied with Helioseal–F (Vivadent); and group 2 (N=9) were applied with Teethmate-F (Kuraray Dental, Japan). Both materials were commercially available in Thailand, and the sealants were used according to the manufacturer's instructions.

Sample collection

The subjects were asked not to brush their teeth the morning of sample collection day. Unstimulated saliva was collected on 3 consecutive days before the sealants were placed to obtain baseline fluoride levels. Then, levels were collected 24 hours, 9 days, 2 weeks, and 4 weeks after the sealants were placed. The plaque samples were collected after the saliva samples on the same day. A plastic tube, with a plastic strip placed inside, was weighed before plaque sample collection. Plaque was removed from all first permanent molars of each subject, using a plastic toothpick, and transferred onto the plastic strip to be placed into the plastic tube, and the tube was tightly sealed. The amount of plaque was determined by the difference of the tube weight before and after sample collection. All samples were frozen at 80°C until fluoride analysis.

Table 1. Mean±SD of Salivary pH, dmft, and dmfs (N=9)

	Helioseal-F	Teethmate-F
Salivary pH	7.19±0.25	7.28±0.20
Decayed teeth	6.11±3.30	5.89±1.54
Missing teeth	0.11±0.33	0.22 ±0.44
Filled teeth	0±0	0.33±0.50
dmft	6.22±3.27	6.44±1.81
Decayed surfaces	15.11±8.99	15.22±6.72
Missing surfaces	0.56±1.67	1.11±2.20
Filled surfaces	0±0	0.56±0.88
dmfs	15.67±9.14	16.89±6.90

Fluoride analysis

Fluoride concentration of the plaque and saliva samples was analyzed via modified microdiffusion technique.[21]

Saliva sample (2 ml) or plaque sample (dissolved in 1 ml deionized water) was placed in a 10 cm plastic dish. Next, 2 ml of 5 M perchloric acid ($HClO_4$), saturated with hexamethyldisiloxane, was added to the samples. A trapping solution, 1 ml of 0.1 M sodium hydroxide (NaOH) in a 3 cm plastic dish, was placed in the 10 cm plastic dish and immediately sealed.

Subsequently, all samples were incubated at 40°C with continuous rotary motion shaking at 100 rpm for 15 hours. After they were incubated, each trapping solution was added with 1 ml of deionized distilled water, 2 ml of 1 ppm standard fluoride, and 0.4 ml of Total Ionic Strength Adjuster Buffer (TISAB III) solution to adjust ionic strength and pH. Fluoride concentration was measured with a fluoride electrode (model 96-09, Orion) which was directly attached to an ion analyzer (model EA 940, Orion). The accuracy of measurement was evaluated by reverse extraction of standard fluoride solution at the concentration of 0.1 and 1 ppm.

Statistical analysis

The fluoride levels of plaque and saliva before and after sealant were analyzed using a paired *t* test, and the fluoride concentration between the 2 types of sealants at the

Table 2. Mean±SD of Salivary Fluoride Levels (ppm) at Different Time Intervals (N=9)

Sealants	Baseline	24 hours	9 days	2 weeks	4 weeks
Helioseal-F	0.10±0.04	0.12±0.04	0.08±0.05	0.15±0.77	0.14±0.11
Teethmate-F	0.08±0.03	0.13±0.11	0.10±0.05	0.13±0.1	0.12±0.1

Table 3. Mean±SD of Plaque Fluoride Levels (ppm) at Different Time Intervals (N=9)

Sealants	Baseline	24 hours	9 days	2 weeks	4 weeks
Helioseal-F	14.71±9.11	50.76±44.34*	16.78±14.14	18.3±8.92	9.11±4.83
Teethmate-F	16.21±9.79	17.36±7.16	11.13±3.57	12.31±4.92	12.49±4.77

*Significant difference=P<.05.

same time interval were compared by a *t* test, with the level of significance at 0.05.

Results

There were no differences in dmft, dmfs, and salivary pH of subjects in both groups (Table 1). The salivary fluoride levels of both groups, before and after application of sealant, were not significantly different. The authors found no significant difference of salivary fluoride levels between the 2 groups at each time interval (Table 2). There was a significant increase of plaque fluoride level after applying Helioseal-F at 24 hours (P=.03). On the other hand, the plaque fluoride level of Teethmate-F was not different from the baseline level. However, the plaque fluoride levels at each time interval showed no difference between the 2 groups (Table 3).

Discussion

The combination of sealant and fluoride can be expected to be additive in the prevention of dental caries. It is more beneficial if the sealant can increase the fluoride level in the oral environment. This study was undertaken in 2 groups of subjects who had similar dmft, dmfs, and salivary pH scores. The reason the authors included the dental status and the salivary pH is that their previous in vitro study showed that pH had an effect on the fluoride release of Helioseal-F (unpublished data). In the present study, the salivary fluoride levels in both sealants were not increased when compared to the baseline. This finding does not coincide with the in vitro study, which reported an increase of fluoride levels at 24 hours.[19]

However, the plaque fluoride levels at 24 hours after sealant application showed the "burst effect" only in the group sealed with Helioseal-F; this result corresponded with the previous in vitro study.[19] This may be explained by different mechanism of fluoride release of the 2 sealants.[17,18] When comparing the difference of fluoride levels at each time interval, the authors did not find a significant difference between the 2 groups; this could result from the large variation of fluoride release of the Helioseal-F group. An in vivo study of Fluoroshield containing sodium fluoride showed that the fluoride concentration of whole saliva increased significantly within 30 minutes after sealant placement, but returned to baseline levels within 1 or 2 days.[22] In this investigation, there was no significant difference due to the fact that the authors collected the saliva at 24 hours. These results fail to demonstrate the long-lasting release of the 2 fluoride-releasing sealants to plaque and saliva; hence, any additional benefit from the sealant would have to derive from fluoride absorbed into enamel underlying the sealant.[2]

The fluoride-releasing sealant was found to lessen the likelihood that caries will form in adjacent cuspal incline enamel and grooves that are not sealed, thereby reducing the formation of caries along the enamel-resin interface.[15] An in vitro study of rechargeability of Helioseal-F pit and fissure sealant reported that, in combination with the phosphoric acid, fluoride had a recharging effect on the resin.[23] However, further clinical study should be investigated on the rechargeability of these fluoride-releasing pit and fissure sealants.

Conclusions

After placement of the fluoride-releasing sealants, only the plaque fluoride level of the Helioseal-F group significantly increased at 24 hours. Saliva fluoride concentration did not increase when compared to baseline in both groups.

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Abstract of the Scientific Literature

Indirectly Bonded Lingual Retainer

Fixed lingual retainer provides essential retention following comprehensive orthodontic treatment. Direct bonding of the retainer is often the clinician's technique of choice. However, contamination of the bonded surfaces and incorrect wire position were frequently encountered with the direct bonding technique. The authors reported a practical indirect bonding method using a 0.0215-inch coaxial stainless steel retainer wire, vacuum-formed tray, and an indirect bonding adhesive system. Prevention of surface contamination, less chair time, and proper placement of the retainer were potential benefits over the direct bonding technique.

Comments: Indirect bonding technique provides a viable alternative for placing a fixed lingual retainer. Fabrications of the retainer using this technique were well described and illustrated in this paper. Nevertheless, scientific evaluations on the efficacy of this system are needed. **BL**

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Karaman AI, Polat O, Büyükyilmaz T. A practical method of fabricating a lingual retainer. *Am J Orthod Dentofacial Orthop*. 2003;124:327-330.

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