ORIGINAL RESEARCH

A Comparative Evaluation of Fluoride Release in Saliva from Fluoridated Pit-and-fissure Sealants, and Glass Ionomer Cements

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Abstract

Aim and objective: The present study was conducted to compare the amount of fluoride released in the saliva after placement of fluoride-releasing pit-and-fissure sealants and glass ionomer fissure sealants at different time intervals.

Materials and methods: The study includes 160 children divided into four groups. Two pit-and-fissure sealants and two glass ionomer cements are tested for fluoride release. Salivary fluoride levels were estimated at baseline and at intervals of 24 hours, 7 days, and 30 days.

Results: The mean baseline salivary fluoride levels were 0.2535, 0.2533, 0.2845, and 0.2635 for group I to group IV, respectively, with no significant differences between the groups. However, an initial salivary fluoride burst effect and peak salivary and plaque fluoride levels at 24 hours were observed in all the groups, i.e., 0.383, 0.34, 0.530, and 0.46 for group I to group IV, respectively.

Conclusion: Fluoride-releasing fissure sealants may act as a source of fluoride in saliva facilitating the prevention of pit-and-fissure caries.

Clinical significance: Fluoride-releasing fissure sealants may act as a source of fluoride in saliva, which can be useful in the prevention of dental caries.

Keywords: Fluoride, Glass ionomer cement, Pit-and-fissure sealants, Saliva.

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Introduction

Dental caries is one of the most common oral diseases with serious consequences both for the patient and also for the public in terms of economic and social concerns.[1] About 90% of carious lesions are found in the pits and fissures of posterior teeth of permanent dentition.[2] Application of pit-and-fissure sealants is one of the effective methods of protecting teeth against pit-and-fissure caries.[3,4] For nearly 5 decades, pit-and-fissure sealants have been used to prevent and control carious lesions on primary and permanent teeth.[5] Pit-and-fissure sealants when applied, it forms a mechanical bond that protects the enamel stratum by arresting the entry of cariogenic bacteria.[6]

The property of resin sealants to release fluoride onto the sealed enamel, adjoining unsealed pit-and-fissure and cusp-inclines of enamel, for a longer duration can bring about a reduction in pit-and-fissure caries. Pit-and-fissure sealants are effective on newly erupted molars and premolars by protecting them from the development of pit-and-fissure caries.[7]

Glass ionomer cements (GICs) are well recognized for discharging fluoride ions with the potential impact of protecting the entire teeth.[8] Fuji IX and Ketac Molar (modified GIC) together with fluoride discharging methacrylate sealants necessitates a comparative study to assess their clinical efficacy while discharging fluoride into saliva from the adjoining sealant-applied tooth structure.

There are very few reported studies on new generation pit-and-fissure sealants and on GICs comparing the levels of salivary fluoride post their applications. Hence, the present study was conducted to compare the amount of fluoride released in the saliva after placement of fluoride-releasing pit-and-fissure sealants and glass ionomer fissure sealants at different time intervals.

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Materials and Methods

A randomized comparative clinical study was carried out in the Department of Public Health Dentistry, Department of Dental Hygiene, College of Applied Health Sciences in Al-Rass, Qassim University, Buraidah, Kingdom of Saudi Arabia. The study was conducted from April 2018 to February 2019. Sample selection was done by a simple random sampling method. In the present study 6–9-year-old schoolchildren were assessed and compared the fluoride discharge into saliva at different intervals of time after applying fluoride pit-and-fissure sealants and glass ionomer contents. A total of 160 children were randomly assigned into 4 groups of 40 each. For children in group I—Helioseal-F (Sealant comprising of fluorosilicate glass), group II—Toothmate-F1 (Methacryloyl methylmethacrylate containing sealant), group III—Fuji IX GP (High-viscidness glass ionomer), and in group IV—Ketac-Molar (High-viscosity glass ionomer) was applied.

Inclusion Criteria

Children aged from 6 to 9 years, with pits and fissures on their permanent first molars and are free from dental caries.

Exclusion Criteria

(1) Children in which the occlusal surface of 1st permanent molars were partially visible, (2) A precise catch with an explorer indicative of cavity on permanent first molars, and (3) Children having restorations or sealants in pit and fissures of first permanent molars.

Approval was obtained from the Institutional board of ethical clearance. The subjects and their parents were enlightened about the scope of the study and written informed consent was obtained from the parents.

Sample Size and Pilot Study

To ascertain the feasibility, a pilot study was carried out before proceeding to the main study. A total of 160 children were divided into 4 different groups with 40 samples in each group and treated with methacrylate and GIC fissure sealants. Based on the results of the pilot study with the standard deviation (SD) of 0.6 and clinical difference of 0.5 has been obtained, with the power of 95% level, the sample size has been calculated to be 160.

Procedure

Wash-out Period

Subjects were given non-fluoridated dentifrice for toothbrushing in the first 10 days preceding the period of study and asked not to resort to any other oral hygiene protocols during the study period, in addition to being cautioned against any food intake containing high fluoride constituents to avoid possible errors likely to affect the results.

Sample Collection

The subjects were instructed against brushing their teeth before sample collection. Baseline salivary fluoride contents were approximated through a collection of unstimulated saliva samples on three consecutive days and the mean was calculated before sealant application. Saliva was collected at baseline (1, 2, 3) and after 24 hours, on the 7th day, and 30th day after fissure sealants application. The average value for each was considered for the statistical analysis.

Method of Pit-and-fissure Sealant Application

The selected tooth (or a quadrant of teeth) was cleanly isolated with cotton rolls and etched with 37% orthophosphoric acid for approximately 15 seconds. The enamel so etched was dried using a compressed air-stream, free from any contaminating oil contents. The etched surface was observed for possible characteristic frost-like appearance. The sealant was, then applied moderately to the prepared surface by gently teasing with brush or probe in pits-and-grooves and was cured using the intensity of light for 15–20 seconds. After curing the material, the upper non-polymerized layer was surface-washed and dried to avoid any change in taste. Occlusal interventions were checked and corrected using articulating paper.

Method of Application of Glass Ionomer Fissure Sealant

The occlusal surface was isolated and treated with polyacrylic acid for 10–15 seconds, and later wash away and air-dried. In line with the manufacturer's recommendations, the glass ionomer (Fuji IX and Ketac molar) was hand-mixed, and placed on the occlusal surface, with the help of suitable tools, and then pushed into pits and fissures with petroleum jelly-coated index finger. Extra material was carved, and subjects were advised against eating for at least 1 hour.

Salivary Fluoride Analysis

Samples of saliva were incubated at 37°C for 3 hours in the presence of phosphatase enzyme to hydrolyze any monofluorophosphate (FPO32-) ions to F, and 0.1 mL of 5 U/L of sodium acetate buffer (pH 4.8) was mixed to 1 mL of a saliva sample. Fluoride ion activity was evaluated in the presence of TISAB buffer with fluoride Ion Specific Electrode ORION (USA).

Statistical Analysis

Data were statistically evaluated with the SPSS version 22.0 IBM Inc., Chicago, USA. Mean and SD were measured for salivary fluoride levels and pH. A one-way ANOVA test was applied for comparing numerous groups along with a comparison by Bonferroni *post hoc*. p values < 0.05 were observed statistically substantial.

Results

In the study conducted on 160 children (68 boys and 92 girls) aged 6–9 years, mean baseline salivary fluoride levels were 0.2535, 0.2533, 0.2845, and 0.2635 for group I to group IV correspondingly, and no substantial deviations were seen among the groups. Table 1 shows mean (SD) values of the fluoride discharge pattern of the four sealants over various time intervals. The arrangement of fluoride discharge for dissimilar fissure sealants was the same except that a great difference was observed in the quantity of fluoride discharged. Glass ionomer designs displayed substantial fluoride discharge levels as related to methacrylate. "Burst effect" salivary fluoride was observed initially with all materials tested (Fig. 1). Fluoride release by the materials at an interval of 7 days was gradual but was the peak at 24 hours in all the groups, i.e., 0.383, 0.34, 0.530, and 0.46 for group I to group IV, respectively, were applied with fissure sealants pointing to a substantial variance among Fuji IX and Helioseal F, Fuji IX and Teethmate F1, Fuji IX and Ketac Molar with Fuji IX fissure sealant revealing the maximum volume of fluoride discharge.

After 7 days' intermission, statically significant variation was observed among Fuji IX and Helioseal F, Fuji IX and Teethmate F1, and Ketac Molar and Teethmate F1, but with no statistical difference between Fuji IX and Ketac Molar. The observed statistical variation among Fuji IX and Helioseal F and Fuji IX and Teethmate F1 has been significant. Of the two fissure sealants assessed, i.e., Helioseal F and TeethmateF1, the variation in salivary fluoride levels were statistically insignificant at all these intervals. Of the two glass ionomer fissure sealants checked-Fuji IX and Ketac Molar–the levels of salivary fluoride were statistically substantial at 24 hours after

Table 1: Mean (SD) values of salivary fluoride levels in ppm, number of subjects for each group 40 subjects in the treatment groups at different time intervals

Group	*Baseline*	*After 24 hours*	*After 7 days*	*After 30 days*
Helioseal-F	0.25 (0.03)	0.38 (0.07)	0.30 (0.06)	0.28 (0.04)
Teethmate F1	0.25 (0.04)	0.34 (0.13)	0.28 (0.04)	0.25 (0.034)
Fuji IX GP	0.28 (0.06)	0.53 (0.10)	0.39 (0.07)	0.32 (0.06)
Ketac molar	0.26 (0.06)	0.42 (0.07)	0.36 (0.07)	0.29 (0.05)

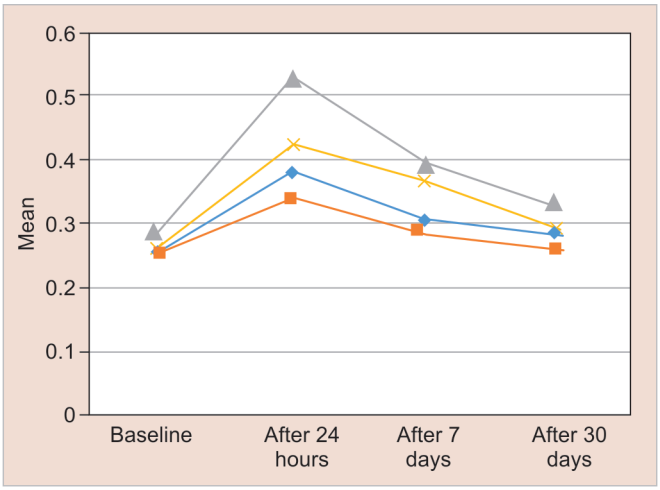

Fig. 1: Mean value of salivary fluoride levels of subjects for the different groups at different time intervals

fissure sealants placement, but the levels were not statistically significant when determined at 7 and 30 days.

Discussion

The pit-and-fissure sealants are broadly categorized into four types: resin-based sealants; glass ionomer sealants; resin-modified GI sealants, and polyacid-modified resin sealants.[9] The present study was conducted to compare the amount of fluoride released in the saliva 30 days after placement of fluoride-releasing pit-and-fissure sealants and glass ionomer fissure sealants.

It was seen that amounts of fluoride discharge occurred more with the groups where glass ionomer fissure sealants were applied. This finding is in accordance with the *in vitro* findings of Dhondt et al.[10] This hypothesizes that a fluoride discharging material like GIC would offer an added advantage of blocking the pits and fissures by a resin-sealant, which was tested multiple times with different glass ionomer materials and also often directly comparing with resin materials.[11] According to a study conducted by Ulusu et al., GIC when used as a pit-and-fissure sealant was slightly more effective than resin-based sealants in preventing occlusal caries.[3]

A slightly raised fluoride accumulation was seen in the saliva after 30 days. Morphis et al.[12] and Tay and Braden[13] mention that maximum fluoride discharge happened for 1 or 2 days, followed by which the levels started diminishing rapidly. Swartz et al.[14] observed substantial release of fluoride from GICs. All of the pit-and-fissure sealants compared in the present study discharged fluoride in quantifiable quantity as could be seen in accordance with the observations of earlier studies.[15]

The study displayed high fluoride values, 24 hours after evaluation of the two groups which was followed by a declining trend upon evaluation at 7 days. By the end of 30 days' evaluation, Fuji IX and Ketac molar sealants presented salivary fluoride contents a little more than baseline values which are in accordance with the observations of Helvatjoglu-Antoniades et al.[16]

Williams et al. observed fluoride discharge from glass powders that were ion leachable upon immersion in distilled water.[17] The concentration of fluoride discharged by methacrylate fissure sealant or GIC is often uncertain, and this is a pointer of variations in the volume of fluoride discharge as reported in the available literature.[18] This study reflects the common finding of variations in fluoride discharge from glass ionomer. The fluoride discharge pattern remained in synchrony with the initial fluoride release burst, followed by sustained leakage.[19]

In the case of composite resins, both poly-acid-modified as well as fluoride-releasing agents, an initial fluoride leaching from glass particles of the materials surface stratum to the burst effect observed in the first few days of sealant application. A slow-release mechanism has been due to the balance in erosive discharging of the scattered filler particles with that of the organic matrix, where fluoride has a distinctly reduced dispersion amount than glass ionomer matrix.[20] This fluoride release pattern suggesting that fluoride discharge occurred as two separate routes–one short-range and rapid, and the other steadier and lengthy.[13] The former is accompanied by a second bulk-diffusion. It has also been observed that the fluoride discharge happens partly due to diffusion through the pores and cracks in the cement.

According to Haznedaroğlu et al., salivary fluoride levels were increased with the one-time application of glass ionomer sealant which has an additive effect on the prevention of dental caries.[21] Fuji IX glass ionomer released more fluoride than other materials investigated so far, including Ketac Molar, Helioseal F, and Toothmate F1. Thus, the present study shows that both Fuji IX and Ketac Molar sealants release low to moderate volumes of fluoride over a period providing complete protection against dental caries.

Dental caries remains one of the most common oral diseases throughout the world. The introduction of fluoride-releasing sealants helps in pit-and-fissure caries prevention.[22] The normal concentration of fluoride in the saliva is about 1 µmol/L, which is somewhat less than that in plasma, and the salivary concentration is relatively independent of flow rate.[23] These salivary levels are expected to be maintained for about 4 weeks. The resin-based sealants and glass ionomer can act as rechargeable fluoride release devices. Which absorb fluoride from fluoride toothpaste into the glass ionomer and subsequently release it into adjacent tooth structure. Hence, sealants have a cumulative benefit for long-term caries reduction.[24]

The average prevalence of dental caries is almost comparable at 5 years and 12 years at 49%. Mean deft/DMFT being 2.36 (2.3–2.42) for 5-year-olds and 1.95 (1.91–1.99) for 12-year-olds.[25] The mean retention rates of RBS and GIS on primary molars over 18 months were 85.94% and 23.18%, respectively. Therefore, a great proportion of children would benefit from these interventions namely the placement of pit-and-fissure sealants.[26]

In the present study after 30 days of pit-and-fissure sealant application, Fuji IX GP showed the highest fluoride reseals (0.32 ppm) followed by Ketac Molar (0.29 ppm), and Helioseal-F (0.28 ppm) and least was in Teethmate F1 (0.25 ppm). Hence, it was observed that Fuji IX GP is effective in releasing higher fluoride into saliva. It can be stated that fluoride discharging efficacy of fissure sealants can help in the prevention of dental caries.

Limitations

Fluoride release can be affected by multiple variables, which could have affected the study results. A rubber dam was not used during the operative procedure and hence it was difficult to control moisture. Moisture contamination, if any, has taken place, it would result in early loss of sealant and hence results in less fluoride release. This was not evaluated in our study since it would require a longer follow-up.

Future Research Needed

Further *in vivo* studies are required to evaluate the fluoride release concentration and duration with different pit-and-fissure sealants.

Conclusion

Glass ionomer restorations may act as intraoral devices for the controlled slow release of fluoride at sites at risk for recurrent caries. Fluoride-releasing fissure sealants facilitate the prevention of pit-and-fissure caries due to their fluoride-releasing properties.

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