FLUORIDE RELEASE OF DENTAL SEALANTS FOLLOWING EXPOSURE TO FLUORIDE TOOTHPASTE AND FLUORIDE VARNISH

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ABSTRACT

Background: Application of dental sealants on pit and fissure areas is an effective intervention to prevent and reduce development of dental caries. Fluoride incorporation into dental sealants increases potency on caries reduction. Fluoride exposure of dental sealant from different sources is expected to enhance fluoride release from dental sealants.
Objective: The study was aimed to compare fluoride release from different dental sealants following exposure to fluoride toothpaste and fluoride varnish.
Methods: Three types of dental sealants were included: Group A- glass ionomer sealant (GIS); Group B- resin sealant and Group C- giomer sealant. Thirty specimens of each material were prepared using stainless steel mold (10×2 mm) and stored in plastic container containing artificial saliva. Initial fluoride release was measured by a specific fluoride electrode every 24 hours for 15 days. The saliva was changed after each measurement. At day 15th, the specimens were randomly divided into 3 subgroups (n=10) and exposed to following regimens; subgroup A- fluoride toothpaste (1000 ppm) twice daily, subgroup B- fluoride varnish (22,600 ppm) once only at day 15th and subgroup C- control group; not exposed to any fluoride regimens. Fluoride release after fluoride exposure was measured for another 15 days. Data were analyzed using one way ANOVA and Games-Howell post hoc test at a significance level of 0.05.
Results: GIS released highest amount of fluoride (42.9±1.91ppm) at the first 15 days followed by giomer sealant (27.79±1.66 ppm) and resin sealant (1.31±0.11 ppm) and showed significantly different among groups (p=0.00). Fluoride toothpaste increases fluoride release from all tested dental sealants while showed superior efficacy on giomer sealant followed by GIS and resin sealant (p=0.00). Fluoride varnish application promotes fluoride release significantly higher in all tested sealants (p=0.00).
Conclusions: Daily exposure of fluoride toothpaste and single application of fluoride varnish enhances fluoride release of all dental sealants.

Keywords: Dental, Fluoride, Toothpaste, Sealants, Varnish,

1. INTRODUCTION:

Dental caries is defined as a progressive irreversible microbial disease affecting hard tissues of the tooth; resulting in demineralization of the inorganic constituents and dissolution of organic constituents, thus leading to cavity formation (Chole et al. 2015). Pit and fissures of occlusal surfaces is highly susceptible site for development of dental caries due to its morphological structure, which aids in microbial adhesion and greater plaque retention (Shimazu et al. 2011)). Application of dental sealants in pit and fissures prevent caries initiation and arrest progression by providing a physical barrier (Dionysopoulos et al. 2016).

Fluoride is most widely used anticariogenic agent and has a broad spectrum of mechanisms of actions which have a major impact in the reduction of caries prevalence (Dhull and Nandlal 2011). The physical effect of dental sealant was enhanced by the incorporation of

fluoride (Lobo et al. 2005). There are various dental sealants are available like glass ionomer sealant (GIS), resin sealant and giomer sealant with fluoride release and recharge capability (Dionysopoulos et al. 2016). Due to the fact that fluoride level leached from dental materials, recharging of these materials with fluoride is recommended, which allows sealants to maintain a continuously increased level of fluoride release (Wiegand et al. 2007). Dental sealants are expected to be more effective in preventing dental caries with enhanced fluoride release property following exposure to different fluoride sources (Shimazu et al. 2011). Till date most of the study on enhancement of fluoride release either focused on high concentration fluoride regimen or single application of low concentration fluoride solution (Poggio et al. 2016, Dionysopoulos et al. 2016). However the impact of daily fluoride exposure using fluoride toothpaste is not well documented.

The purpose of this *in vitro* study is aimed to compare fluoride release from different dental sealants following exposure to home regimen as fluoride toothpaste and professional regimen as fluoride varnish.

2. MATERIALS AND METHODS

Three different dental sealants were included in the study was Group A- GIS; Fuji VII, Group B-resin sealant; Ultraseal XT Hydro and Group C- giomer sealant; Beautisealant. Fluoride regimens used in the study was 1000 ppm fluoride toothpaste- Colgate Total and 22,600 ppm fluoride varnish- Colgate Duraphat. The composition of the materials used in the study is given in table 1.

Table 1: Composition of materials used in the study

Type	Material	Composition	Manufacturer
Glass ionomer Sealant	Fuji VII	Fluoroaluminium silicate glass, polyacrylic acid, polybasic carboxylic acid	GC Corp. Tokyo, Japan
Resin sealant	Ultraseal XT Hydro	Bis-GMA (<20%), UDMA (<10%), DMAEMA (<1%). sodium monofluorophosphate (<1%), titanium dioxide (<1%).	Ultradent Inc. Germany
Giomer sealant	Beautisealant	S-PRG filler based on fluo-roboroaluminosilicate glass, UDMA, TEGDMA, micro fumed silica	Shofu Inc. Kyoto Japan
Fluoride Toothpaste	Colgate Total	Water, sorbitol, hydrated silica, PVM/MA copolymer, Sodium Lauryl Sulfate, flavor, carrageenan, sodium saccharin, triclosan, sodium fluoride	Colgate Palmolive Ltd., Thailand
Fluoride Varnish	Colgate Duraphat	Sodium fluoride (5%w/v), Ethanol (33.8%), white beeswax, shellac, colophony BP, mastic, sodium saccharin, flavour	Colgate Palmolive Ltd., UK

Bis-GMA, Bis-glycidyl dimethacrylate; UDMA, urethane dimethacrylate; DMAEMA, 2-dimethylaminoethyl methacrylate; TEGDMA, triethleneglycol dimethacrylate; S-PRG, Surface pre-reacted glass, PVM/MA- methyl vinyl ether/ maleic anhydride

2.1. Specimens preparation

Thirty specimens of each material were prepared using stainless steel mold- 10 mm in diameter and 2 mm in depth. After packing of the materials into the mold, covered with mylar strip and were light cured using LED curing unit. Manufacturer instructions were followed during preparation of the specimens. All specimens were covered with mylar strip and allowed to set at 37℃ for 24 hours in an incubator. After 24 hours each specimens were stored into clean plastic tube containing 3 ml of artificial saliva and kept into incubator (37℃) for next 24 hours.

Modified Fusayama artificial saliva (pH 5.3) was used in the experiment. The electrolyte composition of saliva was: KCl (0.4g/L), NaCl (0.4 g/L), $CaCl_2.2H_2O$ (0.906 g/L), $NaH_2PO_4.2H_2O$ (0.690 g/L), $Na_2S.9H_2O$ (0.005 g/L) and Urea (1g/L) (Liu et al. 2014).

2.2. Initial fluoride release measurement

Initial fluoride release measurement was carried out once in every 24 hours for 15 days continuously. After every 24 hours, specimens were taken out from the container, washed, dried and put again in 3 ml of fresh artificial saliva for next 24 hours. Measurement was carried out on artificial saliva in which specimens were embedded for past 24 hours. A total ionic strength adjustment buffer III (TISAB III) solution was added at the ratio of 1:10 in order to control pH and prevent formation of fluoride complexes. Fluoride ion selective electrode (Orion 9609 BNWP, Ionplus Sure-Flow Fluoride, Thermo Scientific, USA) with expandable ion analyzer (ORION EA 940, Thermo Electron Corp., USA) was used for fluoride release measurement. Fluoride electrode was calibrated using standard fluoride solutions of 0.1, 1.0 and 10.0 ppm fluoride. All fluoride measurement was taken as ppm.

2.3. Exposure to regimens

At day 15th the specimens were randomly divided into 3 subgroups (n=10) and exposed to following regimens; subgroup A- fluoride toothpaste (1000 ppm) twice daily (morning 8 am and evening 6 pm) for 2 minutes, subgroup B- fluoride varnish (22,600 ppm) once only at day 15th for 5 minutes and subgroup C- control group; not exposed to any fluoride regimens but fluoride measurement were carried out along with other subgroups. After each treatment specimens were put into fresh artificial saliva for next 24 hours.

2.4. Fluoride release after exposure to regimens

Measurement of fluoride release after exposure to regimens was carried out once in every 24 hours for next 15 days with the same method as initial fluoride release measurement method.

2.5 Statistical analysis

All data were analyzed by SPSS 16.0 for Windows. Normality of distributed data was tested by Shapiro-Wilk test. One way analysis of variances (ANOVA) and Games-Howell post hoc test was used for fluoride release measurement comparison at a significance level of 0.05.

3. RESULTS

Initial fluoride release data from tested dental sealants in first 15 days are presented in Fig. 1. All dental sealants exhibit greater amount of fluoride ion release at first day followed by gradual declination and stable fluoride release until day 15th (Fig. 1). GIS released the highest cumulative mean fluoride 42.9±1.91ppm (mean ±SD) in first 15 days followed by giomer sealant 27.79±1.66 ppm and resin sealant 1.31±0.11 ppm. Statistically significant differences were found in initial fluoride released from the dental sealants (p=0.00).

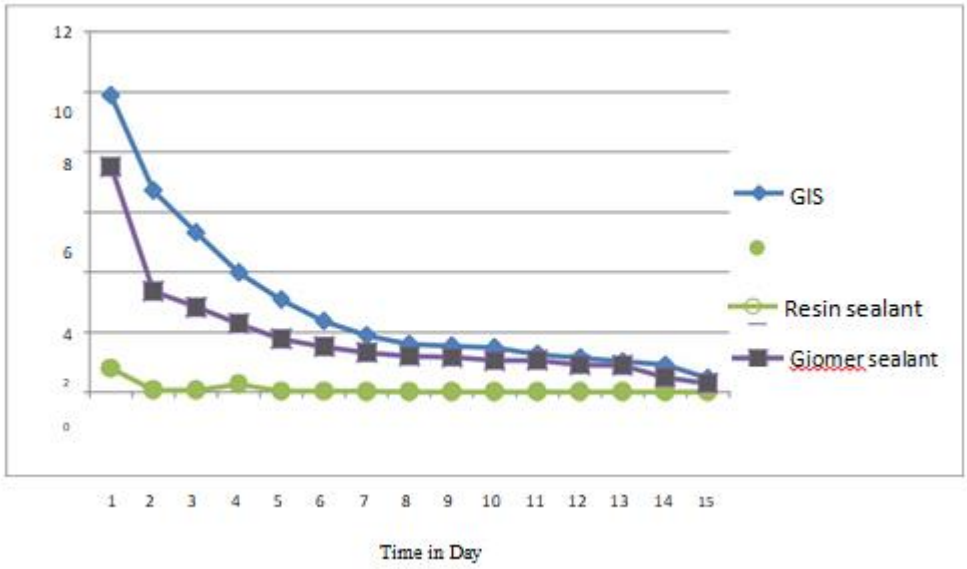

Figure 1: Initial fluoride released from different dental sealants

Cumulative mean fluorides released from dental sealants in 15 days following exposure to both regimens are given in Fig. 2. Following exposure to fluoride regimens all dental sealants released statistically significant (p=0.00) higher fluoride compared to the control group. Application of fluoride toothpaste efficiently increased fluoride release from giomer sealant followed by GIS and resin sealant (p=0.00). Following exposure to fluoride varnish, highest fluoride release was seen from GIS afterwards giomer sealant and resin sealant (p=0.00).

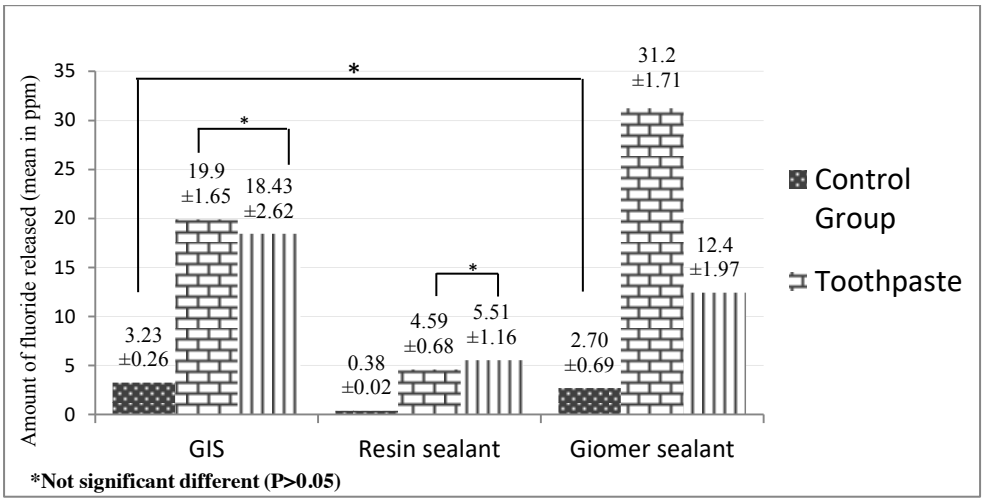

Figure 2: Cumulative mean fluoride released from dental sealants after exposure to different regimens

4. DISCUSSION

Dental sealant is one of the most important primary approaches for prevention of dental caries. For the purpose of tooth structure reinforcement and promoting remineralization, incorporation of fluoride is a beneficial aspect (Salar et al. 2007). The results from this study demonstrated that, all tested sealants are capable to release fluoride in artificial saliva as well as enhanced fluoride release following exposure to different fluoride regimens. In this study fluoride toothpaste exposed to the specimens daily for 15 days to evaluate improvement in fluoride release on daily oral hygiene practice while for fluoride varnish applied once only to figure out effectiveness of professional prophylaxis.

In this study GIS released highest amount of fluoride in first 15 days followed by giomer sealant and resin sealant. GIS are composed of fluoride containing fluorosilicate glass and polyalkenoic acid. Acid-base reactions of these components are responsible for higher amount of fluoride releases from glass ionomer materials (Wiegand et al. 2007). An initial higher amount of fluoride release from GIS in first 24 hours is termed as burst effect, which results due to rapid dissolution from outer surface into solution (Poggio et al. 2016). Similar pattern of fluoride release also observed in previous study by Dionysopoulos et al. (2016) that GIS released highest amount of fluoride when compared to resin sealant and giomer sealant.

Resin sealant (Ultraseal XT hydro) released lowest amount of fluoride among tested sealants. In resin sealant fluoride is added into polymer matrix of resin in form of soluble fluoride salt which leaches into local environment from matrix by water soluble diffusion (Wiegand et al. 2007). Previous studies also stated that GIS usually release higher amount of fluoride ion compare to resin sealant (Poggio et al. 2016). This fact is explained by absence of acid base reaction and glass ionomer matrix formation in resin sealants (Itota et al. 2004).

Initial fluoride released from giomer sealant was significantly higher than resin sealant but lower than GIS. Giomer sealant contains surface pre-reacted glass (S-PRG) technology, allows it to form a stable phase of glass ionomer which further reacts with polyalkenoic acid into silica filled urethane resin which is the main reason for their higher fluoride release capability (Dhull and Nandlal 2011). Shimazu et al. (2011) also found higher amount of fluoride released from giomer sealant when compare to resin sealant and stated that their glass ionomer matrix around glass filler particle is responsible for their better performance.

Exposure to fluoride toothpaste significantly increases fluoride release from all dental sealants compared to control subgroup. Fluoride toothpaste has better capability to stimulate higher fluoride release from sealants due to their high viscosity and sticky nature (Mousavinasab et al. 2009). Giomer sealant demonstrated superiority in fluoride release after exposed to fluoride toothpaste. Previous studies mentioned about highest fluoride re-release capability of giomer sealant due to presence of S-PRG filler (Dionysopoulos et al. 2016). Dhull and Nandlal (2011) stated that increasing fluoride exposure significantly increases fluoride release from giomer. GIS also showed efficient fluoride release after exposure to fluoride toothpaste. Ability of fluoride to temporarily reside in hydrogel layer of GIS is responsible for their increased fluoride release (Itota et al. 2004). Following exposure to fluoride toothpaste, resin sealant released lowest amount of fluoride than other tested sealants but statistically significantly higher than control subgroup. Enhancement of fluoride release after exposure to fluoride sources usually depends on initial fluoride release capacity of the material (Wiegand et al. 2007).

Fluoride varnish promotes significantly higher fluoride release from all tested dental sealants. GIS released highest fluoride after exposed to fluoride varnish. Ability to form polysalt matrix and fluoride uptake from high concentration solutions are responsible for higher release of fluoride from GIS (Poggio et al. 2016). Hereafter giomer sealant also demonstrated enhanced fluoride release followed by resin sealant and statistically significantly higher than control subgroup.

5. CONCLUSIONS

Daily exposure of fluoride toothpaste efficiently enhanced fluoride release from all dental sealants. Superior fluoride release was seen from giomer sealant followed by GIS and resin sealant. Varying in amount was seen due to differences in their composition and structure. Single application of fluoride varnish reinforces fluoride release from all tested sealants but in different extent.

6. ACKNOWLEDGMENTS

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