

Comparative Fluoride Release in Commonly Used Topical Fluoride Agents – An In Vitro Study

Imran Habib¹, Syed Mohammad Danish²

¹Post Graduate Student, Department of Pedodontics and Preventive Dentistry, JDC, Jaipur.

²Post Graduate Student, Department of Conservative Dentistry and Endodontics, JDC, Jaipur.

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ABSTRACT

Background: Fluoride, the pivot of preventive dentistry, continues to be the ideal agent for modern caries prevention philosophy. Differential release of fluoride has implications on cariostatic property of the commercially available materials and thus indicating the importance of fluoride release after the application. Therefore the objective of this study was to assess the difference in fluoride release from the commercially available NaF, SnF₂ and APF as compared to controls at different time intervals. **Methods:** 40 caries free sound premolars were selected for the study and randomly divided into 4 groups (10 specimens each). Teeth specimens in each group were subjected to respective Fluoride treatment i.e. Group I (2% NaF), Group II (8% SnF₂), Group III (1.23% APF) and Group IV (No Fluoride treatment). All specimens were immersed in deionized water and samples collected after 1 hour, 1 day and 1 week were subjected to Fluoride estimation. **Results:** At 1 hour time interval, highest amount of fluoride release ranging from 6.76 to 8.58 ppm was observed in Group II - SnF₂ that was significantly higher than NaF and APF treated specimens. At 1-day time interval, Group II - SnF₂ and Group III - APF showed a higher release of fluoride ranging from 0.81–0.93 and 0.61–0.79 ppm respectively. At 1-week time interval, the fluoride release almost reached baseline values in all the groups except in Group II - SnF₂ that still maintained a high fluoride release ranging from 0.62–0.84 ppm. **Conclusion:** 8% SnF₂ is expected to have greater anti-caries potential than 2% NaF and 1.23% APF gel, due to its high fluoride releasing property for prolonged period of time.

Keywords: APF, Fluoride, NaF, SnF₂, Teeth.

INTRODUCTION

Dental caries continues to plague majority of the world's population with giant unmet treatment needs. It places a large financial, health and time burden most frequently on those least able to bear it.

FLUORIDE, the pivot of preventive dentistry, continues to be the ideal agent for modern caries prevention philosophy.^[1] More than 60 years of extensive research with innumerable publications has repeatedly demonstrated safety and cariostatic effectiveness of this amazing element.

The current focus of attention in Fluoride research is the role of firmly and loosely bound fluoride in caries prevention. Firmly bound fluoride refers to fluoride incorporated in the crystalline lattice of hydroxyapatite i.e. fluorhydroxyapatite (FAP), whereas loosely bound fluoride pertains to fluoride adsorbed to apatite and fluoride leaching from relatively soluble fluoride containing deposits i.e. Calcium fluoride (CaF₂). Today it is a well-known

fact that fluoride in low concentration, i.e. ambient fluoride released from CaF₂ at enamel-plaque-saliva interface has greater caries preventive effects than firmly bound FAP. CaF₂ acts as a fluoride reservoir on the tooth surface and it is formed only during treatment with high concentration fluoride solutions.^[2-8]

Differential release of fluoride has implications on cariostatic property of the commercially available materials and thus indicating the importance of fluoride release after the application.

Though several studies have been conducted on the various topical fluoride agents and their anti caries efficacy but few have reported the amount of fluoride release over a specified period of time. Furthermore, the fluoride release over a longer period of time gives us a reliable information about the anti caries efficacy of the agent.

Therefore the objective of this study was to assess the difference in fluoride release from the commercially available Sodium Fluoride i.e. NaF, Stannous Fluoride i.e. SnF₂ and Acidulated

Name & Address of Corresponding Author

Dr. Imran Habib
Post Graduate Student,
Department of Pedodontics and Preventive Dentistry,
JDC,
Jaipur.

Phosphate Fluoride i.e. APF as compared to controls at different time intervals.

MATERIALS & METHODS

This in-vitro study was conducted in the Department of Pedodontics and Preventive Dentistry, Oral Pathology and Microbiology, Jaipur Dental College, Rajasthan and Department of Biotechnology, Maharaj Vinayak Global University.

40 caries free sound premolars, extracted for orthodontic purpose were washed thoroughly under tap water to remove blood, saliva and tissue debris. Soft tissue and other deposits covering the tooth were carefully removed with scalers and pumice. All the teeth were stored in normal saline at room temperature till the initiation of the experiment. The anatomic roots of all 40 teeth were coated with nail varnish. The teeth were randomly divided into four groups of 10 each for respective topical fluoride application.

All the teeth specimens were blot dried and subjected to their respective topical fluoride treatment. 2% NaF was applied for 20 seconds with cotton applicator and permitted to dry for 4 minutes (Group I). The specimens to be treated with 8% SnF2 and APF gel were immersed in their respective topical fluoride agents for 4 minutes each (Group II and III respectively). Specimens treated with 1.23% APF gel were rinsed with deionized water to remove the gel. All specimens were blot dried. Group IV specimens were not subjected to any fluoride treatment and acted as controls. All 40 teeth were immersed separately in 40 tightly capped plastic containers containing 6 ml of deionized water in each container at neutral pH (at room temperature). After 1 hour each tooth was removed from deionized water and transferred to new 6 ml deionized water containers. After 1 day each tooth was removed from deionized water and transferred to new 6 ml deionized water containers. After 1 week each tooth was removed from deionized water. All 120 samples were subjected to Fluoride estimation.

Estimation of fluoride level in the samples was done using fluoride ion selective electrode method. The Fluoride concentrations of 120 samples were recorded (in ppm) and the values were subjected to statistical analysis.

To compare the fluoride release in the 4 groups; mean and standard deviation of each were analysed by Analysis of Variance (ANOVA).

Further, post hoc analysis was carried out through Tukey’s Honest Significant Difference (HSD). All the statistical calculations were done by SPSS-20.

RESULTS

The present study was conducted to evaluate and compare the amount and pattern of fluoride release

from teeth after topical fluoride application, at different time intervals.

Table 1: Inter-Group Comparison Of The Fluoride Release (Ppm) Between Various Groups At 1 Hour Time Interval

GROUPS	Mean ± SD
I. NaF	3.71 ±0.69
II. SnF2	7.83 ± 0.59
III. APF	3.30 ±0.47
IV. Control	0.50 ± 0.041
ANOVA results were significant	
F	273.83
df	3
p	<0.001

Table 2: Inter-Group Comparison Of The Fluoride Release (Ppm) Between Various Groups At 1 Day Time Interval

GROUPS	Mean ± SD
I. NaF	0.50 ±0.066
II. SnF2	0.87 ±0.043
III. APF	0.72 ±0.058
IV. Control	0.44 ± 0.023
ANOVA results were significant	
F	1.25
df	3
p	<0.001

Table 3: Inter-Group Comparison Of The Fluoride Release (Ppm) Between Various Groups At 1 Week Time Interval

GROUPS	Mean ± SD
I. NaF	0.44 ± 0.025
II. SnF2	0.71 ± 0.063
III. APF	0.50 ± 0.062
IV. Control	0.40 ± 0.021
ANOVA results were significant	
F	0.57
df	3
p	<0.001

DISCUSSION

The purpose of this study was to study the amount and pattern of fluoride ion released over a period of time after topical fluoride application. The fluoride release was evaluated at neutral pH, as it is already known that the release of fluoride is greater in acidic pH.^[2,9] Since topically acquired fluoride may be soluble in saliva, its timely release can have great cariostatic potential by enhancing remineralization.^[10-12]

Fluoride release from teeth was estimated because of its current interest in caries prevention. 2% NaF, 8% SnF2 and 1.23% APF were selected in this study because they are the most commonly used professionally applied topical fluoride agents.^[13] The specimens were kept in deionized distilled water because, it is free from ions and it is easy to measure fluoride, as it is not complexed with any chemical used in the preparation of artificial saliva.^[14]

In this study fluoride release was observed in all the groups, at different time intervals. In the study groups, maximum amount of fluoride release

ranging from 2.44 to 8.58 ppm [Table 1] was seen immediately within 1 hour after topical application, followed by a drastic reduction at 1 day, ranging from 0.37 to 0.93 ppm [Table 2], and a gradual reduction thereafter at 1 week, ranging from 0.38 to 0.84 ppm [Table 3].

At 1 hour time interval, highest amount of fluoride release ranging from 6.76 to 8.58 ppm was observed in Group II - SnF2 which was significantly higher than NaF and APF treated specimens. This could be because of the high fluoride concentration in 8% SnF2 solution (19400 ppmF-).^[15] These findings are similar to that of Skartveit L, Gjerdet NR and Selvig KA,^[16] where they have stated that higher release from SnF2 treated specimens is due to high uptake of fluoride.

At 1 day time interval, there was a drastic reduction in fluoride release in all the groups except in the control group. These findings are similar to those of many studies.^[6-8,17-22] The possible reason for this may be because of the fact that most of the fluoride release occurs immediately within 1 hour.^[23,24] In Group II – SnF2 and Group III – APF a higher release ranging from 0.81–0.93 and 0.61–0.79 ppm respectively was observed as compared to Group I–NaF and Group IV–Control, 0.38–0.48 and 0.40–0.44 ppm respectively. This could be because of high fluoride concentration in SnF2 and APF as compared to NaF.^[15,25]

At 1 week time interval, the fluoride release almost reached baseline values in all the groups except in Group II – SnF2 which still maintained a high fluoride release ranging from 0.62–0.84 ppm. Once again the reason for this could be high fluoride uptake in SnF2 treated specimens due to high fluoride concentration in 8% SnF2 solution.^[15,16,25] The above observations clearly show that 8% Stannous fluoride had highest fluoride release when compared to 2% NaF and 1.23% APF gel at three different time intervals. Further it is expected that the dynamics of release and re-uptake will continue to occur for prolonged period of time.

CONCLUSION

The present study was undertaken for the comparative evaluation of the amount and pattern of fluoride release from teeth after topical application of 2% NaF, 8% SnF2 and 1.23% APF gel at three different time intervals viz 1 hour, 1 day and 1 week. Forty caries free sound premolars were randomly divided into four groups and subjected to their respective topical fluoride treatment. All the teeth were immersed individually separate in deionized water and were transferred to new containers at 1 hour, 1 day and 1 week time intervals. These 120 samples of 6 ml deionized water were divided into

two subgroups of 3 ml each (i.e. 240 samples). Solutions from one subgroup were used for Fluoride estimation by ion selective electrode method.

The following conclusions were drawn from the study:

- Highest amount of fluoride release occurred immediately within 1 hour in all the groups, except in control group, followed by drastic reduction at 1 day and gradual reduction thereafter at 1-week time interval.
- SnF2 treated specimens when compared to that of NaF and APF at all the three different time intervals observed highest Fluoride release. Fluoride release by APF treated specimens was higher than NaF treated specimens at 1 day and 1 week time intervals, but the difference was statistically not significant at 1 week time interval. Thus, 8% SnF2 is expected to have greater anti-carries potential than 2% NaF and 1.23% APF gel, due to its high fluoride releasing property for prolonged period of time.

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