Effect of a Calcium Prerinse on Salivary Fluoride after a 228-ppm Fluoride Rinse

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Key Words
Calcium · Fluoride · Prerinse · Saliva

Abstract
The objective of this study was to determine if a concentrated calcium prerinse given before a fluoride rinse would cause an increase in the post rinse salivary fluoride (F). A panel of 5 subjects used a 30, 150 or 300 mmol/l calcium lactate prerinse followed by a 1-min NaF rinse. All calcium prerinses significantly increased the 1-hour saliva F relative to the NaF control without a prerinse. The maximum increase was produced by the 150 mmol/l calcium lactate prerinse and was about nine-fold higher than the NaF control.

Materials and Methods

Subject Protocol
Rinse administration and the collection of samples were done with the informed consent of the subjects following protocols reviewed and approved by the appropriate institutional review boards. The subjects (5 males) were screened before participation.
to insure good oral health, normal oral architecture, oral physiology and normal salivary gland function. All subjects lived in an area with fluoridated water and were instructed to use their normal oral hygiene procedures. The experiments were done at least 1 h after food ingestion and 3 or more hours after toothbrushing. Three or more days separated each experiment.

**Rinse Administration**
A 20-ml volume was used in all experimental rinses. In the first experiment, the optimum concentration of calcium for use as a prerinse was estimated using calcium lactate pentahydrate as the calcium source (Sigma-Aldrich, St. Louis, Mo., USA). The subjects rinsed for 1 min with a 30 mmol/l, 150 mmol/l or 300 mmol/l calcium lactate solution, expectorated the prerinse, and then immediately rinsed with an NaF rinse (12 mmol/l F – 228 ppm) for 1 min. A 228-ppm F NaF rinse, with no prerinse, served as a control. One potential problem with the highest (300 mmol/l) concentration calcium prerinse is the potential ‘carryover’ of calcium into the subsequent F rinse and hence the loss of F by CaF₂ precipitation in the rinse rather than on oral substrate surfaces. Indeed, preliminary experiments with these same subjects found a 6% carryover of calcium into the subsequent F rinse. However, another preliminary experiment showed that a 10-second water rinse reduced calcium carryover by 96%. Thus, in a second experiment, the subjects rinsed with 300 mmol/l calcium lactate for 1 min, rinsed with water for 10 second, and then rinsed with 12 mmol/l F NaF rinse for 1 min.

**Sample Collection and Analysis**
One hour after application of the F rinses in experiments 1 and 2, unstimulated saliva samples were collected by expectoration for 2 min [Vogel et al., 2001], centrifuged and the supernatant diluted 9 parts specimen with 1 part TISAB III (Thermo-Orion, Shelton, Conn., USA). The specimens were then analyzed using the inverted electrode apparatus previously described [Vogel et al., 1990].

**Statistical Procedures**
A significance level of $p < 0.05$ was used in all statistical tests which were performed using Winks statistical software (Texsoftak, Cedar Hill, Tex., USA). An initial examination indicated that the data were not normally distributed. Thus, in order to normalize the data [Zero et al., 1992a; Vogel et al., 2000; Whitford et al., 2005], a logarithmic transformation of the salivary F levels was used prior to an analysis of variance test of the null hypothesis that there is no difference among the rinses in experiment 1. The Newman-Keuls multiple comparison test was then used on the transformed data to examine the effect of the rinses. For this same reason [Zero et al., 1992a], the geometric mean of the F values was used in place of the arithmetic means and the standard deviation factor (SDF) is presented in place of the standard deviation as a measure of the standard uncertainty. These are calculated by taking the log of the F concentrations, finding the means of the logs and their standard deviations, and then taking the antilogs. The SDF acts multiplicatively rather than additively; geometric means $\times$ SDF.

1 Disclaimer: certain commercial materials and equipment are identified in this paper to specify the experimental procedure. In no instance does such identification imply recommendation or endorsement by the National Institute of Standards and Technology or the ADA Health Foundation or that the material or the equipment identified is necessarily the best available for the purpose.

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**Results**
The results, as given for the geometric mean and SDF, were NaF rinse only 16.8 (SDF 2.1); 30 mmol/l calcium prerinse/NaF rinse 36.2 (SDF 1.3); 150 mmol/l calcium prerinse/NaF rinse 152 (SDF 2.1), and 300 mmol/l calcium prerinse/NaF rinse 126.5 (SDF 1.3). The increases in F relative to the NaF rinse with the calcium prerinses were all statistically significant with the maximum increase (about $\times 9$) being observed with the 150 mmol/l calcium prerinse. The decrease from this maximum with the 300 mmol/l calcium prerinse was not significant. A further decrease in the 1-hour post rinse salivary F, to 81.7 (SDF 1.8), was seen in the second experiment when the 10-second water rinse was used between the 300 mmol/l calcium prerinse and the F rinse.

**Discussion**
The 1-hour post rinse value obtained for the control NaF rinse is larger than values reported in previous studies (about 12 µmol/l) perhaps due to overnight fasting in these previous studies [Vogel et al., 1992, 2001]. Only two studies seem to have been done previously in which a simple calcium rinse was administered before an F treatment. In one in vitro study [Blake-Haskins et al., 1992], a 4.5 mmol/l calcium prerinse reduced lesion depth by 14% compared to the use of F rinse alone. In agreement with these modest results, Whitford et al. [2005] found in an in vivo study that a 20-mmol/l CaCl₂ prerinse used immediately before brushing with an F dentifrice had no effect on salivary F concentrations in which samples were collected 1 h and 12 h after brushing. These results are consistent with the relatively small effect on salivary F observed with the 30 mmol/l prerinse observed in the present study. This suggests that relatively high levels of calcium are required to produce a large amount of deposition of oral calcium F.

The nonsignificant decrease in F with the 300 mmol/l calcium prerinse relative to the 150 mmol/l prerinse might indicate CaF₂ precipitation from calcium carryover into the F rinse. However, when a water rinse was used to reduce calcium carryover (experiment 2), saliva F was further reduced, suggesting that the water rinse removed free calcium from oral tissue.

As noted in the introduction, a ‘controlled release’ type of enhanced F rinse produced a twofold increase in salivary F relative to NaF. As a result, this rinse induced much more remineralization in enamel lesions in an
traoral model [Chow et al., 2000]. This suggests that the very large increases in salivary F produced by the 150 mmol/l calcium prerinse could lead to a still greater cariostatic effect.

The type of calcium therapy described here can be applied in a variety of ways (i.e., as a rinse, a chewing gum, a calcium lozenge, or a calcium dentifrice), and appears to be compatible with most types of F therapies [Vogel et al., 2005]. The only requirement appears to be that the F agent should be applied soon after the application of a soluble calcium agent. Although the large increases in salivary F in this preliminary study is primarily the result of the formation of large bioavailable deposits on soft tissue surfaces [Zero et al., 1992b], the treatment is also likely to deposit large F reservoirs in phases, such as plaque, that are more relevant to caries progression and remission. The effect of the treatment described here on the F concentrations in plaque, and more importantly, its effect on plaque fluid F, remains to be investigated.

Acknowledgements

This study was supported by a grant from the American Dental Association Foundation, and by USPHS Research Grants DE05354 and DE 14707 to the American Dental Association Foundation from the National Institutes of Health – National Institute of Dental and Craniofacial Research and is part of the dental research program conducted by the National Institute of Standards and Technology in cooperation with the American Dental Association Foundation.

References


