



# Fluoride levels in whole saliva of preschool children after brushing with 0.25 g (pea-sized) as compared to 1.0 g (full-brush) of a fluoride dentifrice

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## Abstract

Concerns regarding an increased risk of dental fluorosis related to ingesting fluoride-containing toothpastes by preschool children have led to recommendations to reduce the amount of toothpaste used for young children to a pea-sized amount. The purpose of this study was to determine the effect on salivary fluoride levels of reducing the amount of toothpaste used in a preschool-aged (4–5 years) population. Salivary fluoride concentrations were determined for 10 children whose teeth were brushed with both 0.25 g and 1.0 g of a fluoridated toothpaste on two separate days. Initial salivary fluoride levels following the use of 0.25 g of toothpaste were less than half of the salivary fluoride concentrations when 1.0 g of toothpaste was used, and levels returned to baseline more rapidly. The reduced salivary fluoride levels when less toothpaste is used may result in a reduced efficacy for caries prevention. However, any potential reduction in caries prevention may still be outweighed by the risk of increased fluoride ingestion with larger amounts of toothpaste in preschool children. The results of this study suggest that a reduction in the amount of a fluoridated toothpaste to a pea-sized amount be limited only to young children who are at risk of ingesting toothpaste. (*Pediatr Dent* 18:277–80, 1996)

Fluoride-containing toothpastes are well accepted for their effectiveness in caries prevention. The most frequently used concentration of fluoride in toothpaste is 1000–1100 ppm, though levels of 1500 ppm and 2400 ppm have been tested and shown to somewhat further reduce the incidence of caries.<sup>1,2</sup> Recent concerns over the positive association between fluorosis and toothpaste ingestion by young children<sup>3–6</sup> have resulted in recommendations from a number of healthcare workers to use a pea-sized amount of toothpaste, thus reducing the amount of toothpaste that may potentially be ingested.<sup>7–10</sup> However, in a National Institute of Dental Research sponsored international workshop, *Changing Patterns of Systemic Fluoride In-*

*take*,<sup>11</sup> the lack of data related to efficacy of a reduced amount of toothpaste in preventing caries precluded specific recommendations by that workshop group.

Reducing the concentration of fluoride in toothpaste has been shown to decrease caries resistance.<sup>12,13</sup> In a study of preschool children, Holt and coworkers<sup>14</sup> found that the use of toothpaste containing 550 ppm fluoride as compared with 1050 ppm fluoride in preschool children resulted in fewer enamel opacities. The caries incidence was not significantly different between the two groups in this study, though the authors cautioned that a trend toward increased caries in the children using the lower fluoride toothpaste was apparent. There are no reported studies on the effects of reducing the amount (rather than the fluoride concentration) of fluoride-containing toothpaste on caries incidence in children.

Fluoride concentrations in whole saliva have been shown to be related to efficacy of caries prevention,<sup>15–17</sup> with decreasing caries related to increasing concentrations of fluoride in saliva. The purpose of this study was to determine the effect of using a pea-sized amount of toothpaste on salivary fluoride levels in a controlled clinical setting and to determine the possibility of altered efficacy for caries prevention in preschool-aged children using this regimen.

## Methods and materials

Ten children ages 48 to 50 months were recruited from a daycare center in Rochester, New York, randomly. The children were recruited as follows. All parents at the daycare center were sent a mailing inviting them to participate in a dental screening for their children. Parents of children who met the criteria for the study were then provided with the details of the study design, and asked for further consent to have their child participate in the study. Each parent or legal guardian signed an informed consent statement, which provided for refusal to participate at any time.

All children resided in an optimally fluoridated area. Criteria for inclusion in the study included general good health without evidence of communicable disease. All children had a full complement of teeth with all primary molars present, dental restorations in good repair, and no more than five restorations or carious surfaces per subject. No subject had a deeply fissured tongue or irregular oral mucosal surfaces that might enhance retention of the fluoridated toothpastes.

The night before each study, the investigator called each subject's parents to review instructions. The child was to discontinue all oral hygiene procedures including the use of fluoride-containing dental products until after the test was completed the next morning. The child was to abstain from eating foods high in fluoride (such as sardines) and drinking tea. About 1 to 2 hr after breakfast or consumption of any food or beverage (other than water), a preweighed amount of toothpaste was dispensed from a syringe and placed on a child-sized toothbrush (Crest Cavity Protection Dental Care System™, Procter & Gamble, Cincinnati, OH). The toothpaste (Crest™) had been weighed previously as either 0.25 g (pea-sized amount) or 1.0 g (full brush) in a 10 cc syringe, and stored in the same syringe until use. All tooth brushing was done by a single examiner, and the timing of the collections done by a single assistant. The investigator brushed all surfaces of teeth in the four quadrants for a total time of 1 min, and immediately after brushing the subject rinsed with 5 ml of tap water (containing 1 ppm F) for 10 sec. Brushing with the different amounts of toothpaste and subsequent saliva collection were done randomly on two separate days for each child in the study.

Whole, partially stimulated saliva samples were collected immediately prior to treatment, immediately after treatment, and then at 5, 15, 30, and 45 min and 1 and 2 hr after treatment. All saliva samples were collected with subjects sitting quietly. The children were instructed to pool saliva in the floor of their mouth. Saliva was collected by placing preweighed 3-cm-diameter filtration paper (HP Products, Paducah, KY) in the pooled saliva to absorb approximately 200 µl of saliva for fluoride analysis. The filtration paper was placed into preweighed petri dishes. The total time for saliva collection was less than 1 min. Baseline salivary fluoride con-

centrations for five adults were also measured using the same collection and fluoride analysis methods.

The petri dishes containing the filter disks and saliva were reweighed, and the original weight of the paper and petri dish were subtracted from the total to determine the total weight of the saliva. The fluoride content of the saliva was determined using an ion-specific electrode following diffusion as described by Whitford and Reynolds.<sup>18</sup> A small background amount of fluoride was determined to be present in the filter paper, and was subtracted from the total fluoride measurement. The statistical significance of the differences between the mean fluoride concentration in the saliva in the high and low fluoride groups was evaluated at each time point using a two-tailed Student's *t*-test. Values indicating a probability of  $\leq 0.05$  were regarded as statistically significant.

## Results

The mean salivary fluoride concentrations for the different collection times for each of the two amounts of toothpaste are shown in the Table. Comparisons of these data for salivary fluoride levels in preschool children to a previously published study of salivary fluoride levels in adults brushing with 1.5 g of the same toothpaste also are included. The peak fluoride levels occurred immediately after brushing, with similar peak salivary fluoride levels seen in the preschool children brushing with 1.0 g of toothpaste as in the adults brushing with 1.5 g of toothpaste. The mean salivary fluoride concentration after using 0.25 g of toothpaste was approximately one-third the fluoride concentration after brushing with 1.0 g of toothpaste. Salivary fluoride levels gradually declined, and after 45 min there was no significant difference in the salivary fluoride concentrations between the two groups or as compared to the baseline levels of fluoride.

**TABLE. SALIVARY FLUORIDE CONCENTRATIONS, MEAN PPM F (S.E), AT TIMED INTERVALS FOLLOWING BRUSHING WITH DIFFERENT AMOUNTS OF A FLUORIDATED TOOTHPASTE**

Sampling Intervals	Amount of Toothpaste, Age of Subject		
	0.25 g, Children, 4-5 yr	1.0 g, Children, 4-5 yr	1.5 g,* Adults
Baseline	0.29 (0.56)	0.28 (0.03)	0.10 (0.03)
0 min	4.71 (0.76)	10.89 (1.65)*	9.03 (3.10)
5 min	0.92 (0.18)	2.80 (0.51) <sup>†</sup>	
15 min	0.44 (0.09)	1.25 (0.22) <sup>†</sup>	1.59 (0.57)
30 min	0.23 (0.05)	0.59 (0.12) <sup>†</sup>	0.59 (0.22)
45 min	0.22 (0.04)	0.33 (0.04) <sup>†</sup>	0.25 (0.10)
60 min	0.22 (0.05)	0.28 (0.03)	0.22 (0.08)
120 min	0.33 (0.08)	0.20 (0.04)	0.09 (0.02)

\* Fluoride content of adult whole saliva following brushing with 1.5 g fluoridated toothpaste from Zero et al.<sup>20</sup>

<sup>†</sup> Value significantly different from low fluoride group ( $P < 0.05$ ). Statistical comparisons did not include previous results from Zero et al.<sup>20</sup>

It is of particular interest that the salivary fluoride levels for the children were twice the level for the previously published values for adults, both at baseline and after 120 min. Although only one sample per subject was taken, the standard errors of measurement were relatively small for these samples, suggesting an insignificant measurement error.

To ensure that this difference in baseline salivary fluoride level was not due to a difference in the sampling technique, baseline salivary fluoride values for five adults were measured using the filter paper collection technique. Of the five samples of adult saliva, two were less than accurately detectable limits of the fluoride assay, and the mean fluoride concentrations for the other three samples was 0.112 ppm with a standard deviation (SD) of 0.07. These adult levels are similar to those found by Zero et al.<sup>20</sup> and less than the baseline for the children.

## Discussion

Concerns over the amount of toothpaste ingested by young children and the related increased risk of fluorosis have resulted in recommendations to use a minimal amount of toothpaste when brushing their teeth. Other recommendations have included the use of low fluoride (250 ppm) toothpastes for children. A recent study by Duckworth and Stewart,<sup>19</sup> which measured salivary fluoride levels following the use of various concentrations and volumes of fluoride-containing mouthrinses, indicated that application of a given fluoride dose in a smaller volume at higher concentrations is more effective in raising salivary fluoride levels than application of fluoride in larger volumes at lower concentrations. This suggests that reducing the amount of toothpaste rather than the concentration of fluoride in the toothpaste may be the most efficient way to maintain efficacy while decreasing the risk of fluorosis.

It is also important to determine whether using a reduced amount of toothpaste may have any effect on caries prevention. An inverse association between mean saliva and plaque fluoride concentrations with mean 3-year caries increments was shown by Duckworth and Stewart,<sup>19</sup> indicating that lowered salivary fluoride levels do not afford as much caries prevention. In our study, we showed that brushing with a reduced amount of toothpaste (0.25 g) in preschool children resulted in lower initial salivary fluoride levels, which returned to baseline more rapidly. However, this finding was complicated by the higher than expected baseline salivary fluoride levels in these children.

Our determination of pretreatment baseline salivary fluoride levels in the preschool children as approximately twice as high as the baseline salivary fluoride levels for adults from a similarly conducted study in the same geographical area is of interest. Elevated ductal saliva levels may be responsible in part for the increased baseline levels in the children. This would suggest increased exposure to systemic fluoride by these

preschool children, which could include the ingestion of fluoridated toothpastes. Reducing the amount of toothpaste used could reduce the baseline salivary fluoride levels in children, diminishing the caries-preventive effects. Further studies are needed to conclusively determine whether baseline salivary fluoride levels are higher in preschool children as compared to adults.

A pea-sized amount of toothpaste is appropriately recommended for young children to reduce the risk of enamel fluorosis. However, when the child is able to properly expectorate, our results suggest that the benefit of using a larger amount of toothpaste, which increases the salivary fluoride levels, may outweigh the risks for dental fluorosis. Future clinical studies are needed to determine the effects of a decreased amount of toothpaste on caries incidence in young children.

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