

The use of fluoride-containing toothpastes in young children: the scientific evidence for recommending a small quantity

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THEME ARTICLES

Introduction

The prevalence of dental fluorosis has increased since the 1930s in both fluoridated and nonfluoridated United States communities because of increased exposure to systemic fluorides.¹⁻⁴ Although the increase in dental fluorosis is of the mild and very mild categories and poses no immediate health problem, more severe levels are of esthetic concern and may threaten the continued use of systemic fluorides to prevent dental decay. Indeed, the severity of dental fluorosis in a few isolated populations already has become a public concern (see footnote).⁵⁻⁷ Considering these factors, it is imperative that all possible efforts are undertaken to control the prevalence and severity of dental fluorosis within the range of public acceptance.

In March, 1991, the National Institute of Dental Research sponsored an international workshop, *Changing Patterns of Systemic Fluoride Intake*. In this meeting, fluoride and clinical science researchers discussed issues relating to the safe and effective use of systemic and topical fluorides. Workshop participants agreed that in addition to drinking water, fluoride supplements, and dietary sources, the inadvertent ingestion of toothpaste by young children could be a source of systemic fluoride.

It is a common practice in the dental profession to recommend the use of a small quantity or a pea-size amount of toothpaste for young children. The rationale for this recommendation is to minimize the inadvertent ingestion of fluoride-containing dentifrices, which theoretically could lead to increased systemic fluoride intake. The purpose of this article is to discuss the relationship between fluoride-containing dentifrices and dental fluorosis; in particular, we will examine the scientific evidence for recommending the use of a small amount of fluoridated toothpaste for children.

Literature Review

For dental fluorosis to result, the increased systemic exposure must occur at the age when the enamel is forming.^{8,9} The maturation phase of enamel formation is the stage vulnerable to increased systemic fluoride intake. Chronic high doses of fluoride at this stage can cause enamel hypomineralization.^{10,11} For the maxillary incisors, the critical period seems to be 22-25 months of age, but the risk for dental fluorosis in the incisors may persist for 36 months beyond this period.¹² Fur-

thermore, Ishii and Suckling⁶ showed that increased systemic fluoride exposure from birth for more than 11, 12, and 24 months caused fluorosis in the first permanent molars, the permanent incisors, and premolars respectively. Exposure at 7 years or older did not result in clinically noticeable fluorosis. In light of these findings, we will concentrate on data that pertain to ingestion of fluoride-containing dentifrices in children age 7 years and younger.

Since the 1950s, several studies have been conducted on ingestion of fluoride-containing dentifrices in children; their results were varied. The design of the studies could be classified under two categories. The first estimated toothpaste ingestion by analyzing urinary or fecal excretion of either fluoride or a specific marker.^{13,14} The other estimated toothpaste ingestion by the gravimetric method that measured the difference between the amount of dentifrice used and recovered in each brushing.^{15,16} The former method has been criticized for underestimating the amount of toothpaste ingestion because of technical difficulties and individual variabilities in the rate of absorption, renal clearance, and other physiological parameters.

The latter has been criticized for overestimating toothpaste ingestion because any lost dentifrice was considered ingested. Despite the differences and variability of the results, all of these studies agree on several points:

1. There is a large intra- and interindividual variability in the amount of toothpaste ingested by children during brushing.
2. No child consistently swallows the same amount of toothpaste during each brushing.
3. Younger children swallow more than older children.

The amount of toothpaste reported to be dispensed in each brushing is reported to range from less than 0.1 to more than 2.0 g, with an average estimated to be 1.0 g.¹⁷⁻²⁰ The average amount swallowed is reported to range from 0.13 to 0.33 mg per brushing.¹⁹⁻²¹ The percentage swallowed is reported to range from 14 to 60%.²¹ In a review article, Whitford²² cited an average

Rozier G: Personal communication, unpublished data, 1991.

amount of 25% swallowed. Because most toothpastes on the market contain 1000–1100 ppm F, it is reasonable to suggest that an average of about 0.25 mg of fluoride will be ingested by children during each brushing. A child who brushes twice a day may ingest 0.5 mg of fluoride from toothpaste alone.

A recent study by Maurice and Levy²³ revealed that a large majority of preschool children seemed unable to expectorate effectively. Whitford²² made a similar observation and attributed this to the inadequate development of the swallowing reflex in younger children. Although there is no evidence in the literature that supervised brushing can reduce the amount of toothpaste ingestion among young children, parental supervision in limiting the quantity of toothpaste dispensed is a common-sense approach to reducing inadvertent fluoride ingestion.

The fluoride in toothpastes is readily bioavailable,²⁴ meaning that virtually all fluoride ingested from toothpaste is absorbed. It has been shown that ingesting 0.6 g of toothpaste containing 1000 ppm fluoride can lead to an increase in the plasma fluoride level^{25, 26} comparable to that attained after swallowing 0.5 mg of sodium fluoride tablets.²⁷ Polishing agents such as calcium phosphate and calcium carbonate have been shown to inhibit fluoride absorption to some extent,²⁸ however, silica, which is present in most toothpastes available today, has been shown not to affect the absorption of fluoride from toothpaste ingestion.^{25, 26}

The optimal daily allowance of fluoride from all sources is 0.05–0.07 mg/kg of body weight;^{29–31} any amount exceeding this may cause dental fluorosis. Thus, a 2-year-old child at 12-kg body weight should not exceed 0.8 mg/day. Ophaug³² estimated the dietary fluoride intake of a 2-year-old child to range from 0.2 to 0.6 mg/day, depending on the fluoride level in the drinking water. Hence, this child may ingest 0.2 to 0.6 mg of fluoride per day from dietary sources, plus 0.5 mg from fluoridated toothpaste. This total of 0.7–1.1 mg of fluoride per day may exceed the maximum allowance of 0.8 mg/day for the 2-year-old child. When intake from other systemic sources is considered, such as fluoride supplements³³ and beverages,³⁴ there is an even greater chance that young children may exceed their optimal daily fluoride allowance.

In a recent review of the literature, Ripa²¹ made a conservative estimate of 0.13 mg of fluoride intake from toothpaste ingestion per brushing in preschool children. This is probably an underestimation because he assumed an average of only 0.5 mg of toothpaste and the use of a child-size toothbrush in each brushing. Nevertheless, he concluded that toothpaste ingestion could contribute to total systemic fluoride intake and suggested guidelines that included the use of only a

pea-size amount of toothpaste for young children to minimize inadvertent ingestion.

Several epidemiologic studies have investigated the association between toothpaste use and prevalence of dental fluorosis. The early epidemiologic studies demonstrated a lack of association,^{35, 36} but these have been criticized for the lack of statistical power to detect a relationship because the sample sizes were small and the prevalence of dentifrice use was high. Some early studies did not control for other confounding variables.^{37, 38} Often, these studies were designed primarily to investigate other systemic sources, such as fluoride supplements^{39–41} and water fluoridation.^{36, 42, 43}

The more recent epidemiologic studies have found an association between toothpaste use and the prevalence of dental fluorosis.^{37, 44–46} Milsom and Mitropoulos⁴⁶ conducted a study in Cheshire, England, and demonstrated that significantly more children between ages 0–4 years in a fluoridated community who began brushing at an earlier age exhibited enamel defects. Similar findings were reported by Osuji et al.⁴⁴ in Toronto, Canada. The investigators found that children who started toothbrushing before the age of 22 months were 11 times more likely to develop dental fluorosis than those children who began later. Wöltgens et al.⁴⁵ showed that there was increased enamel mottling in children who began using fluoride supplements and brushing with toothpastes containing 1500 ppm fluoride before the age of 4 years. In a recent study, Pendrys and Katz³⁷ concluded that toothpaste use from the third through the sixth year of life put children at a 2.9 times greater risk for development of dental fluorosis.

Summary and Conclusion

The scientific literature shows large variability in the amount of toothpaste ingested by young children. Although no study has demonstrated that children swallow a large amount of toothpaste consistently, all investigators agree that toothpaste ingestion can contribute to total fluoride intake. The prevalence of toothpaste use is high among children. Dowell¹⁷ reported that 85% of 2-year-old children brush with fluoridated toothpaste. Wöltgens et al.⁴⁵ and Simard²⁰ reported similar findings. Recent epidemiologic studies have demonstrated an association between early toothpaste use and increased prevalence of dental fluorosis in children. This finding should not be surprising in view of the high prevalence of toothpaste use among young children^{17, 20, 45} and their estimated average toothpaste ingestion. Reducing the fluoride concentration in toothpastes from the standard 1000–1100 ppm may reduce the amount of fluoride ingestion from this source. However, studies on the efficacy of toothpastes with reduced fluoride levels on the prevention of dental decay

are inconclusive.²¹ Because there are no data to quantify the optimal amount of toothpaste to be dispensed in each brushing, the recommendation of using only a pea-size amount for young children is prudent and scientifically sound.

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