

Influence of Rinsing and Expectorations After Toothbrushing on Fluoride Dose and Ingested Amount by Use of Conventional and Children's Fluoride Dentifrices

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The purpose of this study was to assess the amount of ingested fluoride and the fluoride dose to which children are subjected during toothbrushing with a conventional dentifrice (1500 ppmF) and a children's dentifrice with special flavor (1100 ppmF) and evaluate the influence of rinsing and expectoration after brushing. Six brushings followed by 6 residue collections (3 per dentifrice) were performed by 42 Brazilian children (aged 20 to 30 months). The concentration of fluoride in the residues and dentifrices was determined. The amount ingested was obtained by the difference principal. 64.3% of the children did not expectorate or rinse after brushing. For both toothpastes, no significant difference was found for fluoride doses comparing children that rinsed to those that did not rinse ($p \geq 0.05$). When children's toothpaste was used, children who did not expectorate were exposed to a higher dose than those who did expectorate ($p=0.032$). The same was not observed when conventional toothpaste ($p=0.081$) was used. In conclusion, rinsing and expectoration after brushing had no influence on the dose of fluoride to which children were exposed by use of the dentifrices. However, expectoration was directly associated to the fluoride dose when the children's dentifrice was used.

Key Words: fluoride, dentifrice, dental fluorosis, expectoration and rinsing.

INTRODUCTION

For many years, dentistry has been concerned with dental caries and have search means of interfering with the installation and progression of this disease, especially with use of fluoride (F). The discovery of its cariostatic effect has transformed fluoride into the most important anticariogenic agent (1). Since the cariostatic effect of topical fluoride was first demonstrated, there has been interest in using it in a variety of ways and including it in dentifrices, which are widespread sources of fluoride (2,3).

Since the 1950s, fluoridated dentifrices have become an effective way of promoting fluoride delivery in direct contact with the teeth, where it can exercise its cariostatic effect (1). The use of fluoride dentifrices has been an important factor in caries decrease, but inadvertent ingestion during brushing and use at an early age have been associated to an increase in the prevalence and severity of dental fluorosis among children (2,4-8).

Currently, there is considerable concern regarding fluoride dentifrices used by children under the age of 6, which is considered a critical dental development period for aesthetic alterations, including dental fluoro-

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sis. It is also a phase when control over the swallow reflex is as yet underdeveloped. As such, a large part of the dentifrice ends up being swallowed, whether voluntarily or involuntarily (5,9).

Children aged 20 and 30 months are considered at the greatest risk for development of dental fluorosis in the permanent upper incisors, as this is a transition period between the end of the secretory phase and the beginning of the maturation phase of these teeth (10).

Dentifrice ingestion during toothbrushing by children at this age is a proven fact. It has been shown that while brushing their teeth, children aged 20 to 30 months ingested 63.5% (7) and 56.9% (8) of fluoride from the dentifrice. Paiva et al. (2005) (11) investigated the daily amount of conventional and children's dentifrices ingested by children in this age group and found that the ingestion of children's dentifrice (60.8%) was higher than that of conventional dentifrices (52.2%).

Thus, the use of topical fluoride present in dentifrices has become systemic because of inadvertent ingestion by children during toothbrushing. Knowledge of the dose of fluoride to which children are subjected upon use of fluoride toothpastes has attracted the attention of a number of researchers (12).

Although the effectiveness of fluoride in dentifrices has been proven, it is also known that its use imposes a risk/benefit relation to users. Therefore, exposure to fluoride by use of fluoride dentifrices should yield a reduction in caries prevalence without bringing any risk of dental fluorosis.

The purpose of this study was to assess the amount of ingested fluoride and the fluoride dose to which children are subjected during toothbrushing with conventional and children's dentifrices and evaluate the influence of rinsing and expectoration after brushing.

MATERIAL AND METHODS

The present study had the participation of 42 children (18 female and 24 male) in the age group between 20 and 30 months (27.12 ± 3.68). All children were residents in the city of Belo Horizonte, MG, Brazil, which has optimal fluoridation of the public water supply (0.7 ppm F, ranging from 0.6 to 0.8).

The option of only including subjects at that range was based on the fact that children at this age are considered to be at greater risk for the development of fluorosis in the permanent anterior teeth (10,13).

The study population comprised a non-randomized sample of convenience, enrolled at schools located in strategic regions with distinct economic levels. Children were evaluated for determination of their economic class in accordance with the National Association Research Companies (ANEP, 2001) (14). This index is composed of the sum of points conferred to the schooling of the head of the family and possession items. The Research Ethics Committee of the Federal University of Minas Gerais (UFMG) (ETIC no. 185/01) approved the study protocol.

After defining the schools, a consent form and questionnaire were sent to the parents/guardians for data collection. The questionnaire should gather general information on both children and parents, including history of contact with fluoride and oral hygiene habits, especially use of fluoride dentifrices. There was 18.5% total refusal of the questionnaire and 81.5% return rate. A pilot study was carried out to test the collection method, define the sample size and determine possible difficulties in understanding the questionnaire.

Sorriso[®] (1500 ppmF) and Tandy[®] (1100 ppmF) dentifrices were chosen for the study because the parents/guardians cited these brands in the questionnaire responses as the most habitually used toothpastes. Definition of the sequence of dentifrice type to be used in the first 3 brushings for all cases was determined randomly by lots. The interval between brushings for residual collection ranged from 5 to 7 days.

To achieve the proposed objectives, a cross-sectional study was carried out with a blind evaluation. The children were unaware which type of dentifrice was being used at the time of brushing in order to avoid bias as a result of such knowledge. The researcher alone had knowledge as to the type of dentifrice used. Care was taken to use a similar size and format of the dentifrices used. A strip of crepe paper was applied to the entire length of the tubes, blocking out both the brand name and coloring of the packaging, thereby avoiding the identification of the dentifrice.

In all brushings, 0.50 g of dentifrice was used, which is the amount of dentifrice cited in studies involving children in the same age group (12). This amount was obtained by weighing the toothbrush on a precision balance (A&D Weighing, SV-200, Milpitas, CA, USA) accurate to 0.01 g before and after placing the dentifrice onto the bristles.

Based on questionnaire responses, brushing was

carried out at school in accordance with the children's routine habits. The children themselves performed the brushing, under supervision of teachers and/or assistants when they were not able to do it alone. No formal instruction regarding brushing technique was given not to interfere with the technique that they routinely used. Six brushings were performed (3 brushings *per* dentifrice), with 6 collections of residues for each child. During toothbrushing, when the child expectorated or rinsed his/her mouth (which was done with deionized distilled water), expectorate and rinsed water were collected in a plastic cup. Deionized distilled water used to rigorously wash out the brush was also collected in the same plastic cup. The suspension collected was denominated "brushing residues", which were homogenized and measured by volume. Figure 1 shows a flowchart describing the study design.

Deionized distilled water was used in all brushings to determine the amount of fluoride originating in the fluoride dentifrice alone.

To assess the amount of fluoride ingested, difference principal methodology was used, taking care to assure that dentifrice residues did not remain on the lips, face or hands of the volunteers not to overestimate the results. Residues were removed with a wooden spatula or the child's toothbrush. Each child was weighed while clothed, without shoes, using a home-use scale (Indústrias Filizola Balanças SA, São Paulo, SP, Brazil) to determine the weight (kg) and calculate the dose of exposure to fluoride (mg F/kg).

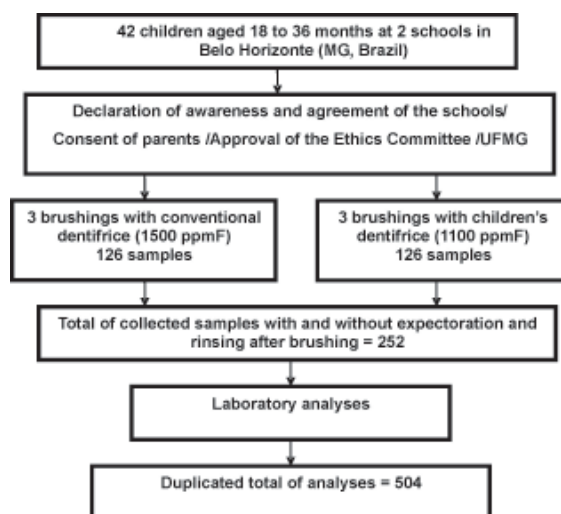


Figure 1. Flowchart describing the study design.

Analyses were performed at the Oral Biochemical Laboratory of the Faculty of Dentistry of Piracicaba (UNICAMP) to determine the fluoride content in the dentifrices and brushing residues.

The amount of fluoride ingested during toothbrushing was calculated by subtracting the amount of fluoride recovered from the brushing products from the amount initially used (weight of dentifrice times concentration of total soluble fluoride). By multiplying this amount by the number of daily brushings, divided by the child's weight, the fluoride dose to which the child was daily subjected by brushing with fluoride toothpaste was determined.

All fluoride analyses were performed using an ion-specific electrode (9609BN; Beverly, MA, USA) coupled to an ion analyzer (EA940; Orion) previously calibrated with solutions of known fluoride concentration under the same conditions as the sample (hydrolyzed with HCl 1 M at 45°C, neutralized with NaOH 1 M and buffered with 50% TISAB II).

Student's t-test was used for statistical analysis of the independent samples to verify the association between the dose and amount of fluoride ingested with rinsing and expectoration. All statistical analyses were carried out using SPSS v. 8.0 (SPSS Inc., Chicago, IL, USA) and S-Plus 2000 (MathSoft, Inc., Seattle, WA, USA) softwares. Significance level was set at 5%.

RESULTS

Student's t-test was used on the independent samples to assess the association between rinsing and expectoration after brushing. All analyses were carried out twice - once for the conventional dentifrice and the other for the children's dentifrice.

The distribution of the children regarding the frequency of expectoration and rinsing after toothbrushing are shown in Table 1. Most children did not expectorate or rinse.

Table 1. Absolute and percentage distribution of children according to expectoration and rinsing after toothbrushing.

	Expectoration	Rinsing
Yes	15 (35.7%)	15 (35.7%)
No	27 (64.3%)	27 (64.3%)
Total	42 (100%)	42 (100%)

Table 2 displays the association between the amount of dentifrice ingested, the dose of fluoride to which the children were subjected and rinsing after toothbrushing. There was no association between the amount of conventional ($p=0.974$) or children's dentifrice ($p=0.708$) ingested relative to rinsing. Likewise, there was no association between fluoride dose to which the children were subjected by using either conventional ($p=0.352$) or children's dentifrice ($p=0.153$) relative to rinsing his/her mouth.

Table 3 displays the association between the amount of dentifrice ingested, the dose of fluoride to which the children were subjected and expectoration after toothbrushing. There was no association between the amount of conventional ($p=0.138$) or children's dentifrice ($p=0.066$) ingested in relation to the child having expectorated. Likewise, there was no association between the dose of fluoride to which the children were subjected by using conventional dentifrice in

relation to the child having expectorated after brushing ($p=0.081$). For the children's dentifrice, however, there was a statistically significant difference ($p=0.032$) between the fluoride dose to which the children were subjected by using this dentifrice in relation to the child's habit of expectorating. The children that did not expectorate were subjected to a higher dose than those that did expectorate.

From Tables 2 and 3, it may be observed a dose variation ranging from 0.01 to 0.08 mg F/kg for weight/day regarding the use of conventional and children's fluoride dentifrices in relation to the habits of rinsing and expectorating after brushing.

DISCUSSION

The discovery of the anticariogenic properties of fluoride constitutes one of the most important watershed moments in dentistry. Fluoride has the capacity of

Table 2. Average, standard deviation, minimum and maximum values of the amount of fluoride ingested daily (mg F/day), dose of fluoride to which the children were subjected (mg F/kg/day) and rinsing after dental brushing.

Type of Dentifrice	Rinsing after brushing	Amount of F ingested (mg F/day)	<i>p</i>	Dose of F (mg F/kg/day)	<i>p</i>
Conventional Dentifrice	Yes	0.565 ± 0.394 (0.171 to 0.959)	0.974	0.041 ± 0.025 (0.016 to 0.066)	0.352
	No	0.568 ± 0.248 (0.320 to 0.816)		0.048 ± 0.022 (0.026 to 0.070)	
Children's Dentifrice	Yes	0.604 ± 0.430 (0.174 to 1.034)	0.708	0.043 ± 0.027 (0.016 to 0.070)	0.153
	No	0.644 ± 0.253 (0.391 to 0.897)		0.055 ± 0.025 (0.03 to 0.080)	

Table 3. Average, standard deviation, minimum and maximum values of the amount of fluoride ingested daily (mg F/day), dose of fluoride to which the children were subjected (mg F/kg/day) and expectoration after dental brushing.

Type of Dentifrice	Expectoration after brushing	Amount of F ingested (mg F/day)	<i>p</i>	Dose of F (mg F/kg/day)	<i>p</i>
Conventional Dentifrice	Yes	0.475 ± 0.255 (0.220 to 0.730)	0.138	0.038 ± 0.023 (0.015 to 0.061)	0.352
	No	0.621 ± 0.317 (0.304 to 0.938)		0.051 ± 0.022 (0.029 to 0.073)	
Children's Dentifrice	Yes	0.510 ± 0.293 (0.217 to 0.803)	0.066	0.040 ± 0.027 (0.013 to 0.067)	0.153
	No	0.700 ± 0.319 (0.109 to 0.381)		0.058 ± 0.023 (0.035 to 0.081)	

interfering with the initial stages and progression of caries disease (15).

Recently, there has been great discussion about the appropriate use of fluoride regarding an exposure that assures the benefits of reducing caries prevalence and minimizes the risk of dental fluorosis. Dentifrices are widely utilized as vehicles for local delivery of fluoride. However, there is a risk of young children ingesting fluoride, as such children do not yet have adequate control over the swallow reflex (9).

Over the last 10 years, toothpastes with special flavors have been commercialized to attract children. However, there is great discussion over the extent to which this attraction is related to a greater ingestion of the dentifrice, and whether this pleasant flavor is leading children not to make the effort to rinse and expectorate all the dentifrice retained in the mouth (16,17). Therefore, the use and ingestion of an increased amount of flavored children's dentifrice could expose children to a dose of fluoride that is higher than that considered "safe" and cause dental fluorosis.

Therefore, this study investigated the dose and amount of fluoride children ingested upon use of a conventional and a children's dentifrice with special flavor, in relation to rinsing and expectorating after brushing.

During toothbrushings, most children did not expectorate or rinse (64.3%) (Table 1). These results are consistent with those of a recent study (18), which found that the number of children who rinsed or expectorated was around 31%.

The findings of this study showed no association between the amount of dentifrice ingested and the children's habit of expectorating after brushing, regardless of the type of dentifrice. No statistically significant difference was found regarding dentifrice dose and the children's habit of expectorating relative to the use of the conventional dentifrice. However, as for the children's dentifrice, those that did not expectorate were exposed to a higher dose of fluoride. This fact suggests that the special flavor of children's toothpaste leads children to a greater acceptance of this dentifrice. This can influence the frequency of brushing and the amount ingested and expectorated after brushing, and might increase the risk of developing dental fluorosis. In a study comparing the use of conventional dentifrice and children's dentifrice among subjects aged 31 to 60 months, it was observed that children expectorated the conventional dentifrice

(56%) more than the children's dentifrice (50%), although this study did not collect data regarding the ingestion of fluoride (19).

For both types of dentifrice, no association was found regarding fluoride dose, amount of dentifrice ingested and child's rinsing habit. This result agrees with those of Naccache et al. (5), who stated that rinsing is only beneficial to children over the age of 5, as younger children ingest approximately the same amount of dentifrice whether they rinse or not. This is probably due to lack of control over the swallow reflex, often leading young children to swallow the water used in the rinsing itself. Another study (17) reported that most children that use water for rinsing after brushing do not totally expectorate it. On the other hand, other studies (2,16,18,20) have advocated that rinsing was associated to a reduced ingestion of dentifrice.

It is noteworthy that the use toothpaste itself subject children to a dose that is very close to the limit for the risk of fluorosis (0.05 to 0.07 mg F/kg of weight/day). Moreover, it should be kept in mind that this dose does not include fluoride from other sources, such as fluoridated water, food and supplements.

In the present study, there was a dose ranging from 0.01 to 0.07 mg F/kg of weight /day with use of the conventional dentifrice, and from 0.01 to 0.08 mg F/kg of weight /day for the children's dentifrice. It should be noted the broad variability of the individual dose found, which means that one child may be exposed to a dose of 0.08 mg F/kg of weight/day, whereas another is exposed to 0.01 mg F/kg of weight/day. Such results indicate that some children are subjected to a greater risk, regardless of the dentifrice used. This emphasizes the importance of disseminating information regarding the adequate use of either type of dentifrice among children, including orientation from health professionals and toothpaste manufacturers, highlighting the use of minimal amounts of dentifrice and the need for supervising children during toothbrushing.

Longitudinal studies should be conducted to assess the occurrence of dental fluorosis with use of fluoride dentifrices in function of children's rinsing and expectorating habits after brushing, comparing data from conventional and children's dentifrices. Such investigations should contribute to ensure the effectiveness of fluoride delivered by fluorides in controlling dental caries without causing dental fluorosis.

Regardless of the type, the children ingested a

large amount of dentifrice, which can represent a risk for developing dental fluorosis. Most children did not expectorate or rinse after brushing. No differences were found regarding fluoride dose in relation to rinsing, irrespectively of the type of dentifrice. Children that did not expectorate after using children's dentifrice were exposed to a higher dose of fluoride than those that did expectorate, but this fact was not observed when the conventional dentifrice was used. The special flavor of children's toothpaste can lead children to a greater acceptance of this dentifrice, thereby influencing the amount ingested and expectorated. Toothpaste manufacturers and health professionals should adopt educative methods aimed at reducing the ingestion of fluoride delivered by this source.

RESUMO

O objetivo deste estudo foi analisar a quantidade de fluoreto ingerido e a dose a que crianças estão expostas através do uso de dentifricio convencional (1500 ppmF) e infantil com sabor especial (1100 ppmF) e avaliar a influencia do enxágüe e expectoração pós-escovação. Realizaram-se 6 escovações (3 com cada dentifricio) e coletas dos seus resíduos, em 42 crianças de 20 a 30 meses de idade, residentes em Belo Horizonte, MG, Brasil. Determinou-se a concentração de fluoreto nos resíduos coletados e dentifricios utilizados. Pelo princípio da diferença foi obtida a quantidade ingerida. 64,3% das crianças não realizaram a expectoração e o enxágüe. Quando comparada a dose com o fato da criança ter feito enxágüe ou não, nenhuma diferença significativa foi encontrada ($p \geq 0,05$), independentemente do tipo de dentifricio. Quando usado o dentifricio infantil, as crianças que não expectoraram estavam expostas a uma dose superior às que expectoraram ($p=0,032$), o mesmo não foi observado com o uso do dentifricio convencional ($p=0,081$). Conclui-se que o enxágüe e a expectoração pós-escovação não tiveram influencia sobre a dose de fluoreto a que as crianças estavam expostas pelo uso do dentifricio. Entretanto, no caso do dentifricio infantil, a expectoração esteve diretamente associada à dose.

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