Salivary fluoride concentration in adults after different fluoride procedures

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Today, several alternatives for fluoride therapy are available. To give advice on the choice of method, the dentist should have information on how effective different fluoride treatments are in increasing salivary fluoride concentration. The aim of the present study was to measure the fluoride concentration of saliva after the use of four different fluoride methods commonly used in the Nordic countries: F mouthrinse (0.023% F), F toothpaste (1.1% F), F lozenge (0.25 mg F), and F chewing gum (0.25 mg F). In addition, a new method using toothpaste–water mixture as a mouthrinse was included in the study. Fourteen adult volunteers used each of the five methods on separate days. Unstimulated saliva samples were collected at base line and 0, 10, 20, 30, 45, and 60 min after the fluoride procedure. Fluoride was separated by the microdiffusion method and analyzed using a fluoride-specific electrode. Fluoride mouthrinse and fluoride toothpaste increased the fluoride concentration of saliva significantly more than fluoride lozenge and fluoride chewing gum. For both of the latter, salivary fluoride concentration was still increased after 1 h. Toothpaste–water rinse was more effective than brushing with toothpaste. Rinsing with toothpaste-water mixture appears a good alternative for adults who need extra fluoride therapy but are not motivated enough to brush their teeth several times a day. □ *Fluorides; preventive dentistry; saliva; toothpaste*

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The results of several studies support the concept that frequent use of preparations with relatively low fluoride concentration is effective in reducing the rate of demineralization of the enamel even under high caries challenge (1–3). Several alternatives for increasing the fluoride concentration in the mouth, such as fluoride toothpastes, fluoride rinses, fluoride lozenges, and fluoride chewing gums are available. Although the choice of method depends greatly on the preference of the patient, the dentists has an important role in advising the patient which method to choose. To be able to do this, the dentist should have information on how effective each of these methods is in increasing the fluoride concentration of saliva.

Although salivary fluoride concentrations after topical fluoride treatments have been studied considerably, there are few studies comparing different methods in the same setting (4). Moreover, in older studies many of the preparations used today have not been included. In recent years, research has been focused on the effect of brushing habits on the salivary fluoride concentration after toothbrushing (5–9). The results of these studies suggest that postbrushing habits resulting in rapid elimination of fluoride from saliva are associated with reduced caries prevention. The same is likely to be true of other modes of fluoride application.

The aim of the present study was to measure the fluoride concentration of saliva after the use of four different commercial fluoride preparations commonly used in the Nordic countries. In addition, a new method using a fluoride toothpaste–water mixture as a fluoride rinse was included in the study.

Materials and methods

Fluoride procedures

Fourteen healthy adults, dental students and members of the staff of the University Dental Clinic of Kuopio, volunteered for the study. Their age varied between 20 and 57 years, the mean age being 35 years. All participants used each of the five methods on separate days. The participants were told not to brush their teeth after lunch. The fluoride procedures were performed after lunch between noon and 1400 h, as follows:

1. F rinsing: The participants rinsed for 30 sec with 10 ml fluoride solution (Pepsodent Fluor®, Lever, Elida Gibbs, Helsinki, Finland; 0.023% F as NaF) followed by expectoration.
2. Rinsing with toothpaste: A toothpaste slurry was formed by placing 1.5 g toothpaste (Colgate Fluor®, Colgate-Palmolive, Glostrup, Denmark; 0.11% F as NaF) and 10 ml tap water in the mouth. The toothpaste was dispersed around the mouth and mixed with water by means of tongue and cheek movements, to form a 'solution'. The mouth was rinsed for 30 sec with the solution, which was then spat out. No water rinsing was performed afterwards.
3. Toothbrushing: The teeth were brushed for 60 sec with 1.5 g Colgate Fluor toothpaste, followed by expectoration and a single rinse with 10 ml of tap water (0.1 ppm F). No special instructions with regard to brushing method were given.
4. F lozenge: A fluoride lozenge (Fluden®, Apothekernes Laboratorium A.S., Oslo, Norway; 0.25 mg F as

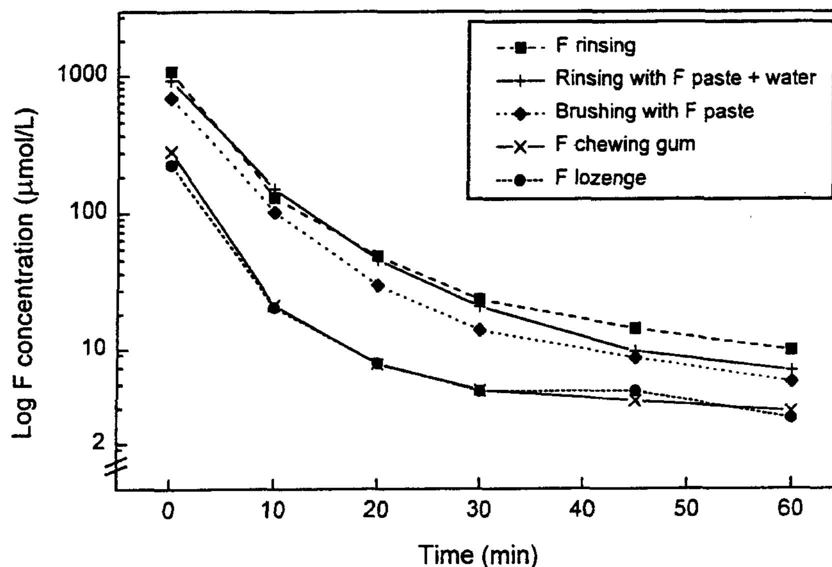

Fig. 1. Mean fluoride concentrations in whole saliva after dierent fluoride procedures.

NaF) was allowed to dissolve slowly in the mouth completely without chewing it.

5. F chewing gum: One piece of Fluorette® chewing gum (Fertin A/S, Denmark; 0.25 mg F as NaF) was chewed for 5 min and then expectorated.

Collection of salivary samples and determination of fluoride

Before each experiment 2 ml of unstimulated saliva was collected (base-line sample). The second sample of saliva was collected immediately after each fluoride procedure and the following samples (2 ml each) 10, 20, 30, 45, and 60 min after the second sample. The participants were told not to eat or drink anything or rinse their mouth between these samples.

The samples were stored frozen until determination of fluoride (−80 °C). Before the analyses the samples were centrifuged (4300 *g*). Fluoride was separated by the microdiffusion method (10) and analyzed using a fluoride-specific electrode (Orion 960 Autochemistry system; Orion Research, Boston, Mass., USA).

Statistical methods

Statistical evaluation of differences in salivary fluoride concentration and area under the curve ($AUC_{0\text{-}60\ min}$) values (11) were performed using Hotelling's *t* tests and paired *t* tests. The level of statistical significance was set at 0.05.

Results

The mean salivary fluoride concentrations after different fluoride methods are shown in Fig. 1. Table 1 shows the mean values and standard deviations at five different time points. The highest peak values for fluoride were found after rinsing with fluoride solution and after toothpaste–water rinse. For F rinsing, toothpaste–water rinsing, and toothbrushing, salivary fluoride concentrations were still significantly increased after 60 min compared with the base-line value. The mean $AUC_{0\text{-}60\ min}$ values are shown in Fig. 2. The values for F rinsing and

Table 1. Salivary fluoride concentrations (µmol/l) after different fluoride procedures

	Base line		0 min		10 min		30 min		60 min	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
F rinsing	2.8	0.6	1082.4	511.6	130.6	108.1	23.6	26.6	9.9	7.8
Rinsing with F paste and water	3.0	0.7	934.3	485.4	160.0	134.6	20.8	22.1	7.0	4.3
Brushing with F paste	2.8	0.7	695.4	388.3	102.7	81.9	14.0	8.2	5.8	2.8
F chewing gum	3.0	0.6	282.2	210.1	21.4	13.2	5.0	2.2	3.5	1.4
F lozenge	3.8	5.5	224.5	133.5	20.6	15.3	4.9	2.0	3.1	1.5

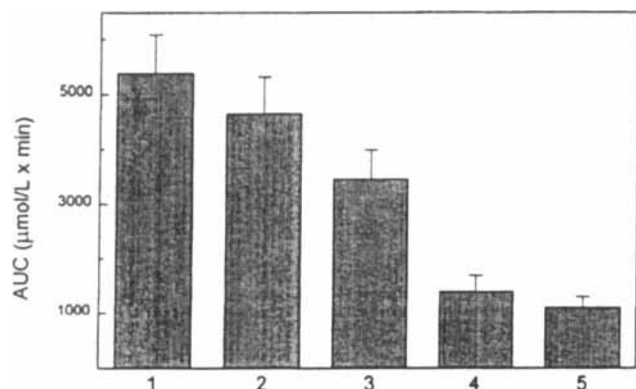

Fig. 2. Mean (and standard error) area under the curve ($AUC_{0-60\ min}$) for different fluoride procedures. 1 = F rinsing; 2 = rinsing with F paste and water; 3 = brushing with F paste; 4 = F chewing gum; 5 = F lozenge.

rinsing with toothpaste and water were significantly higher than for the rest of the procedures, and that for brushing with toothpaste was significantly higher than those for F chewing gum and F lozenge. There was no significant difference between the two last procedures.

Discussion

It is well known that clearance of fluoride is affected by several factors, especially the salivary flow rate of an individual. However, since we compared different methods in the same subjects, salivary flow rate was most probably the same during each test period and thus did not affect the comparison of the methods. Frequent collection of samples probably interfered with salivary fluoride retention and may have influenced the absolute values of fluoride at different time points, but since all series of experiments were carried out in the same manner, comparing the results of the various procedures seems right to us. We did not restrict the use of fluoride before the experiment because this is not done in real-life situations either. However, the experiments were carried out in the afternoon, to avoid the interference of morning brushing with the base-line fluoride value.

The main finding of the study was that fluoride mouthrinse and fluoride toothpaste increased the fluoride concentration of saliva clearly more than fluoride lozenge and fluoride chewing gum. For both, salivary fluoride concentration was still significantly increased after 1 h, whereas it had returned to base-line level after the use of fluoride lozenge and fluoride chewing gum. We did not study fluoride clearance for more than 1 h, but on the basis of previous studies (4, 5, 12) it can be estimated that the base-line level of fluoride was reached within approximately 2 h.

Fluoride toothpaste is a well-accepted means of fluoride delivery. However, most persons who need extra fluoride therapy are not motivated enough to brush their teeth several times a day. For these people, using a mixture of toothpaste and water as a fluoride mouthrinse is a simple and inexpensive alternative. In the present study this method was also more effective in increasing the fluoride concentration of saliva than toothbrushing. A somewhat similar method has previously been described by Sjögren & Birkhed (7). However, in their study water was mixed with toothpaste foam after toothbrushing, and the slurry was used for rinsing. In our toothpaste-rinsing method no toothbrush was used. The fact that the participants did not rinse their mouth with water after the toothpaste–water rinse probably increased the fluoride concentration of saliva. Even though our participants had no complaints, omitting the water rinse may not feel appealing to all patients. In that case a short rinse can be recommended. The toothpaste rinsing method is naturally not a method of choice for children, who cannot control their swallowing. We are not suggesting that it should replace toothbrushing, but it might be used as an additional fluoride application during the daytime.

With regard to fluoride rinsing, dilute fluoride mouthwashes sold over the counter have been strongly marketed and have gained popularity during the past years. According to the present results, their use should be encouraged for persons who like to use them. The reason for the great retention of fluoride after rinsing with fluoride solution is probably also the fact that in this method fluoride is not rinsed off with water afterwards.

Fluoride lozenges have largely replaced conventional fluoride tablets and are today considered an alternative to fluoride therapy for persons of all ages. In Finland they are often recommended for patients with dry mouth. It has been shown that in xerostomic subjects salivary fluoride concentration remains increased for a longer period than in subjects with normal salivary flow rate after all modes of fluoride application (12). However, our results suggest that in healthy adults salivary fluoride concentration remains relatively low after the intake of one fluoride lozenge containing 0.25 mg fluoride and that this method may not be the best way of topical fluoride treatment. The same seems to be true of fluoride chewing gum. Relatively rapid clearance of fluoride after the use of fluoride lozenges or chewing gum is probably partly due to stimulation of salivary flow due to sucking and chewing. Using a larger dose of tablets and chewing gums would certainly result in higher salivary fluoride concentrations but is not generally recommended.

When considering the results it must be kept in mind, however, that small differences in salivary fluoride concentration may not be crucial for the caries-preventive efficacy of different fluoride preparations. The most important thing is that the method is accepted by the patient and is used regularly.

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