Effect of Different Fluoridated Dentifrices on Salivary pH and Fluoride Content

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Aims: The study was aimed to establish the influence of toothpaste fluoride (F) concentration on salivary F levels and pH in order to evaluate oral F retention.
Material and methods: Thirty-four healthy young volunteers participated in this study performed on two separate occasions in which the subjects brushed their teeth with low- and conventional fluoridated dentifrices: 1) 500 ppmF and 2) 1450 ppmF. Three samples of whole unstimulated saliva were collected from each participant in all occasions: T1 – before brushing (baseline), T2 – right after brushing and T3 – 60 min. after completing each experimental procedure. Salivary pH and F concentration were determined. The Mann-Withney test was used for statistical analysis.
Results: The mean salivary F values (mean value±SD) measured right after toothbrushing were 1.439±0.732 when low-fluoride dentifrice was used and 4.160±2.53 with 1450 ppmF toothpaste, respectively. One hour after toothbrushing salivary F decreased significantly compared to the T2 values ($p<0.001$), however remained significantly higher than baseline in both occasions: 1) 0.159±0.026 (T3), and 2) 0.29±0.206 (T3). No significant differences could be observed between the salivary pH values.
Conclusions: After toothbrushing with fluoridated toothpaste containing 500 ppmF and 1450 ppmF, salivary F concentration increased significantly and remained elevated above the baseline one hour after brushing. The results suggests that toothpaste with higher F concentration could have more efficacy in caries prevention. Salivary pH is not influenced by fluoride content of dentifrices.

Keywords: fluoridated toothpaste, salivary F, salivary pH

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Introduction

The benefits of fluoride (F) as a public health measure have been well demonstrated and documented over the past few decades. Recent evidences suggested that the cariostatic effect of fluoride is mostly exerted by its topical rather that systemic effect [1–3].

Fluoride topical mechanisms include: 1) inhibition of demineralization at the crystal surfaces inside the tooth; 2) enhancement of remineralization at the crystal surfaces (the resulting remineralized layer is very resistant to acid attack); and 3) inhibition of bacterial enzymes [3–5]. Fluoride in drinking water and in fluoride-containing products reduces tooth decay via these mechanisms. Low but slightly elevated levels of fluoride in saliva and plaque provided by these sources help prevent and reverse caries by those mechanisms [4–7].

The most common source of topical F are fluoridated dentifrices, considered the most cost-effective and efficient means of caries prevention [2,6,7]. The optimal F concentration on toothpaste was the subject of numerous studies during time, especially in the case of children, since they swallow a part of the paste, which increases the risk of fluorosis due to the overdose [8–11]. The commercially available toothpastes contain F in different concentrations between 200 ppmF and 1500 ppmF. It is of clinical interest to know how much fluoride is dissolved within the oral cavity after application of fluoride dentifrices during toothbrushing, how much of fluoride remains after expectorating the toothpaste and what is the optimal level of F for caries protection. Dentifrices with low fluoride content offer a higher security, but they are less efficient in caries prevention [11–13]. The F bioavailability in saliva from toothpaste is influenced by many factors such as fluoride concentration[14-16], dentifrice pH [15–18], rinsing habits after brushing [19–22], frequency of dentifrice use [23], F formulation [24], salivary secretion rate, salivary pH, amount of dentifrice applied to the brush [25,26].

It was found that a "therapeutic level" of F in saliva at around 0.1 pmm, maintained day and night, would give almost complete protection against caries progression [27].

The aim of this study was to determine the salivary pH and Fcontent after tooth brushing with different F concentration dentifrices in order to assess their efficacy in caries prevention.

Material and method

The study was approved by the Research Ethics Committee of the University of Medicine and Pharmacy of Tîrgu Mureș. This crossover study comprised 34 healthy young volunteers. They consent after verbal and written information on the aim and performance of the study.

The study was conducted on two separate occasions in which the participants brushed their teeth with a controlled amount of dentifrice (full brush covered – approxi-

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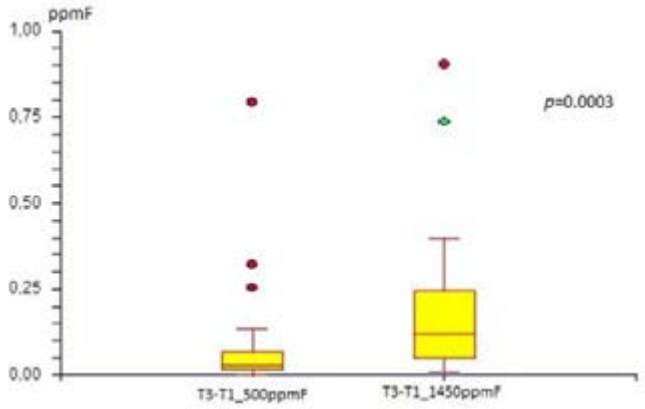

Fig. 1. Difference between the mean salivary F concentration determined 60 min. after toothbrushing

mately 1 g) with different F concentration tooth paste: 1) 500 ppmF and 2) 1450 ppm F. Three samples of whole unstimulated saliva were collected from each participant in all occasions: T1 – before tooth brushing, T2 – right after habitual tooth brushing and T3 – 60 min. after completing each experimental procedure.

The pH of each saliva sample was determined with a pH meter (HANNA HI 4521). The samples were centrifuged (HETTICH – UNIVERSAL 320R) for 15 min. at 4000 rpm in microcentrifuge tubes. From each sample 1 ml was taken and mixed with 1 ml of a TISAB buffer solution (Total Ionic Strength Adjustment Buffer). A Vortex mixer (FALC) was used before F measurement for homogenization of samples content. The salivary F content was determined using a fluoride sensitive electrode (9609 BN) connected to a fluoride meter (ORION 720A). All measurements were made twice for accurate results and arithmetical means was used.

The data obtained were introduced in the data base and analyzed using statistical software NCSS/PASS Dawson Edition. The Mann-Withney test was used for statistical analysis to compare the F concentration determined in different occasions.

Results

Table I presents the data of F concentration (ppm) determined in each occasion.

Immediately after toothbrushing the salivary F content increased significantly compared with baseline ($p<0.001$) in both situation – use of 500 ppmF dentifrice and 1450 ppmF, respectively.

One hour after tooth brushing salivary F decreased significantly compared to the T2 values ($p<0.001$), however remained higher than baseline. The difference between the mean salivary F levels in T1 and T3 was statistically significant in both occasion ($p<0.001$).

One hour after toothbrushing the mean salivary F concentration were 0.159±0.026 when toothpaste with 500 ppmF was used and 0.29±0.206 after use of 1450 ppmF dentifrice. The difference between the mean salivary F levels in T1 and T3 was statistically significant in both occasions ($p<0.001$).

Table I. Summary of data obtained for salivary F content (ppm) (n=34)

	500 ppmF			1450 ppmF		
	T1	T2	T3	T1	T2	T3
Mean	0.083	1.439	0.159	0.111	4.160	0.290
SD	0.026	0.732	0.152	0.062	2.535	0.206
Median	0.074	1.165	0.113	0.092	3.385	0.225
Min	0.045	0.223	0.048	0.057	1.090	0.100
Max	0.157	2.950	0.866	0.393	9.200	0.970

Statistically significant difference was found between baseline values of salivary fluoride concentration determined on each occasion ($p=0.017$). For more accurate results T1 values were extracted from T3 prior to compare the mean values of salivary levels determined 60 min. after toothbrushing in both situations. The results indicate a statistically significant diference between the mean salivary F level (T3–T1) determined one hour after toothbrushing with dentifrice containing 500 ppmF (0.076±0.145) and the mean salivary F level determined one hour after toothbrushing with dentifrice containing 1450 ppmF (0.178±0.192) with $p<0.001$ (Figure1).

There was no statistically significant difference between salivary pH dtermined before brushing (6.926±0.324) and the values measured one hour after completing each experimental procedure 7.047±0.235 in case of using toothpaste with 1450 ppmF and 7.093±0.267 when dentifrice with 500 ppmF was used.

Discussions

Finding ways to ensure as much as possible an optimal therapeutic level of F in the oral environment was the subject of numerous studies during time.

Considering that the most widespread source of F is represented by fluoridated dentifrices, several studies have focused on the idea of finding the most appropriate formula to reach maximum benefits with minimum risk. Low levels of fluoride – like those found in saliva and plaque after regular toothbrushing with fluoridated dentifrice might have a profound effect on enamel demineralization and demineralization [13,14,16,17,28].

Regarding the influence of F concentration Twetman in a systematic review conducted in 2003 and updated in 2009 concluded that toothpaste with 1500 ppm of fluoride had a superior preventive effect compared with dentifrices with 1000 ppm F in children's permanent dentition [25].

Comparable results were found following another systematical review conducted by Walsh (2010). They concluded that there is no statistically significant difference in the caries protective effect of the dentifrices with low F level (440/500/550 ppm) when compared to placebo in children up to 16 years of age with a follow-up period of at least 1 year [13].

In our study we considered a concentration of 0.1 ppmF as "therapeutic level" of salivary F that can provide anti-caries effect according to the findings of Featherstone (2006) [27]. We have found that after habitual toothbrushing with dentifrices containing 500 ppmF and 1450 ppmF, the fluoride level increases considerably and after 60 min. and it remains elevated in both situations, above the level considerate optimal, with a higher level in the case of the tooth paste with higher F concentration. The results of our study were similar with other studies performed in this field [14–16]. Several studies show that 120–240 min after tooth brushing the salivary F concentration decreased at the baseline level depending on the toothpaste F concentration, fluoride formulation, salivary secretion rate and post-brushing habits [14,26].

Fluoride retention in saliva and plaque increases significantly with the frequency of application [23].

More recently it has been shown that pH considerably influence F penetration into enamel. The results of the study conducted by Buzalaf (2009) show that the reduction of dentifrice pH increase F uptake in dental plaque but does not affect F bioavailability [15].

Similar studies were conducted to evaluate the effectiveness of acidic low-fluoride dentifrices compared to conventional neutral dentifrices. The results of those studies clearly demonstrated that low-fluoride (412–550 ppmF) acidified toothpaste (pH 5.5) had the same anticariogenic action as the 1.100 ppmF neutral dentifrice [16–18].

The salivary fluoride levels after toothbrushing with fluoridated dentifrice are also affected by the rinsing procedure. Issa et al. (2004) used nine different toothpaste and different post brushing habits in their study. The results showed that the use of the aminofluoride toothpaste with 1400 ppmF in the highest fluoride content of saliva without water rinsing after 120 min. [20]. Duckworth (1991) and Sjogren (2001) concluded after a study regarding the salivary F retention after toothbrushing with fluoridated dentifrice that rinsing habits may play an important role in the oral retention of F from dentifrice which may, in turn, affect their clinical efficacy [21,22].

Conclusions

– Salivary F content increases significantly right after toothbrushing with fluoridated toothpaste.
– Sixty minutes after toothbrushing the F concentration recorded a significant decrease, however remained elevated at an optimal level for caries protection.
– Salivary F levels measured 60 minutes after toothbrushing are directley related to dentifrices F content.
– Toothpaste with higher F concentration could have more efficacy in caries prevention.
– Salivary pH is not influenced by the fluoride content of dentifrices.

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