Oral clearance of NaF from chewing gum and tablets in children and adults

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ABSTRACT. Aim of the present study was to evaluate the salivary clearance of Fluoride following administration of tablets and chewing gums containing 0.50 mg of Fluoride in the form of NaF. Materials and methods Ten children (age 10-13 years) and a control group of 10 adults (age 22-27 years) were recruited and selected for the study. The experiment consisted of saliva samples collection from each participant at fixed time intervals. Whole saliva was sampled from ten 10-13 years-old children to assess the baseline fluoride concentration, then participants received one piece of chewing-gum and were asked to chew for 15 minutes. Whole saliva samples were collected 5, 10, 20, 30, 45 and 60 minutes after the chewing period. The day after once again we administered a chewing-gum to each child, instructing them to continuously chew it for 15 minutes; subsequently we collected saliva samples at the same intervals previously fixed. The following day the experiment was repeated, this time requesting the patient to chew as slow as possible for 15 minutes and then new samples were collected. Saliva samples were collected at the same intervals previously fixed from control group of 10 adults. After a week, children’s group received one tablet and new saliva samples were collected at the same intervals. The collected samples were analysed by a potentiometric method, assessing the Fluoride concentration by means of a Fluoride ion-selective electrode. Results The clearance of Fluoride is similar for both the administration methods used. Conclusion Both chewing gum and tablets are valid methods of Fluoride administration and they can be considered useful aids in dental caries prevention (when used in addition to adequate oral hygiene).

Keywords: Fluoride, Saliva, Tablets, Chewing gum.

1993; Oztas et al., 2004], while other researches evaluated the role of chewing gum on oral health [Edgar and Geddes, 1990; Imfeld, 1999; Ithagarun and Wei, 1997] and some focused on the Fluoride saliva concentration after gum chewing [Sjogren et al., 1997; Oliveby et al., 1987; Bruun and Givskov, 1978]. Other literature findings regard the salivary kinetic of Fluoride [Ekstrand et al., 1990; Lagerlof et al., 1987; Dawes and Weatherell, 1990] and the factors able to influence its clearance [Lagerlof et al., 1987; Lagerlof and Oliveby, 1990].

The main advantage of the use of Fluoride chewing gums is that topical applications of Fluoride can be repeated, thus maintaining the salivary levels within therapeutic ranges [Lamb et al., 1993], moreover chewing gums stimulate salivation allowing to capitalise of the beneficial effect of saliva [Serpico and Cozzolino, 1997; Ithagarun and Wei, 1997].

Studies have related the use of Fluoride-based toothpastes, rinses, varnishes, chewing gums and tablets to the reduction of caries incidence in selected groups of subjects, proving that the administration of low doses of...
Fluoride for long periods is beneficial in caries prevention [Leverett et al., 1985; Marino et al., 2003].

Aim of the present study was to assess the salivary clearance of Fluoride following administration of fluoridated tablets containing 0.50 mg of Fluoride in form of NaF (ZymaFluor tablets 0.50 mg, Novartis Consumer Health, Origgio, Italy) and fluoridated chewing gums containing 0.50 mg of Fluoride in form of NaF (ZymaFluor Gum 0.50 mg, Novartis Consumer Health, Origgio, Italy).

**Materials and methods**

The experiment was performed at the Department of Operative Dentistry of the University of Pisa on a group of patients consisting of: 10 children (age 10-13 years) and a control group of 10 adults (age 22-27 years), selected according to two basic exclusion criteria:
- absence of systemic diseases able to interfere with the salivary excretion;
- no concomitant pharmacological therapies able to alter the salivary secretion.

**Materials used for the study**

1. Fluoridated chewing gums, containing 0.50 mg of Fluoride in form of NaF (ZymaFluor Gum 0.5mg, Novartis Consumer Health, Origgio, Italy) for both the adults and children groups.
2. Fluoridated tablets, containing 0.50 mg of Fluoride in form of NaF (ZymaFluor tablets 0.5 mg, Novartis Consumer Health, Origgio, Italy) only for the children group.

Participants were requested to refrain from drinking and eating for 2 hours before the test in order to avoid analysis bias due to the presence of exogenous Fluoride from the ingestion of food and drinks containing Fluoride. A toothpaste containing 500 p.p.m F as NaF (Oral B, Oral B laboratories, Newbridge, Ireland) was used by the subjects twice a day (7 a.m. and 7 p.m.) for the whole experimental period. Saliva samples were collected from children to determine the baseline fluoride concentration then participants received one piece of chewing gum containing 0.50 mg of F as NaF and were asked to chew for 15 minutes. The subjects were allowed to swallow deliberately. Whole saliva samples were collected 5, 10, 20, 30, 45 and 60 minutes after the chewing period. The day after, each children received one tablet containing 0.50 mg F as NaF and new saliva samples were collected at the same intervals. The tablet was sucked until it was completely dissolved in the mouth. The subjects were allowed to swallow deliberately.

To avoid the risk of exogenous fluoride contamination, all the plastic ware used was prewashed with 35% perchloric acid and 50 mg diphenylsilanediol in toluene and then rinsed in acetone.

During measurement the temperature of the solution and the complete apparatus was maintained at 20° C within +/-0.5° C by controlling room temperature.

The analyses were performed at the Chemistry and Industrial Chemistry Department laboratories of the University of Pisa, according to the following method.

The Fluoride content of the saliva samples was measured by a potentiometric method using a fluoride-specific electrode (Hanna instrument) which potential depends on the Fluoride concentration in the sample solution according to the equation:

\[ E = E^0 + \frac{RT}{F} \log_{10} C_F - f_F \]

Where \( E^0 \) is the standard potential of the electrode that depends on its construction, \( CF^- \) is the fluoride concentration in the sample and \( f_F \) is the coefficient of the sample ionic strength. Standard solution are prepared properly diluting a stock solution of sodium fluoride (1mg/l) in the 0.26-2.48 mg/L concentration range then a calibration curve is constructed plotting the measured electrode potential against the logarithm of Fluoride concentration.

A Calomel electrode (mercury/mercurous chloride) was used as reference electrode. Deionised water was used for solution preparation and calibration was daily checked before every set of sample analysis.

In order to minimise the volume of the saliva necessary for the measurement, the device shown in figure 1 was set up. It consisted of two polyetilene tubes with an internal diameter similar to that to the electrodes.

The two tubes were connected by a short piece of silicone tube with a smaller internal diameter that
allows the electrical contact between two electrodes. A 2 ml aliquot of saliva was poured inside the tubes and the two electrodes were positioned as in the figure. The electrodes and the tubes were rinsed with deionised water before each measurement.

**Analysis of the results obtained with chewing gums**

**Children group**

The results obtained by analysis of the saliva samples collected from the children, after fluoridated gum chewing, were the following.

The Fluoride concentrations in the samples collected before the gum chewing were, as expected, lower than the levels detectable by the instrument. Thus the values obtained after the subjects chewed were ascribed only to the Fluoride released by the chewing gums.

All the values obtained from the analysis of the samples collected at fixed intervals (5, 10, 20, 30, 45 and 60 minutes after the gum chewing) were registered and the results are showed in figure 2, from the mean values obtained by the analysis of the first set of samples we draw the Fluoride clearance: the ion concentration lowers as time goes by.

The data analysis shows that the Fluoride concentration gradually lowers as time goes by and after one hour, in fact, the high F- concentration levels detected after 5 minutes from the end of the chewing are very low and tend to zero.

The standard deviation obtained for the 5 and 10 minute sample, represented by the black segments in the graph, caught our attention: the mean value of the samples shows a large standard deviation.

The experiment was then repeated on the adult control group so to compare the obtained values and verify if the standard deviation was going to be similar.

Within the examined subjects, two distinct subgroups emerged: the first subgroup comprised those subjects where, in the 5 and 10 minute collected samples, a high concentration of Fluoride was detected; in the second are patients who showed low concentrations of Fluoride at the same intervals (fig. 3).
After 10 minutes in both subgroups the Fluoride concentration lowered below 3 mg/l, regardless of the initial values. We assumed that the difference in concentration in the 5 and 10 minute samples was related to a different chewing pattern, and we set a test to verify our hypothesis.

Once again we administered a chewing gum to each participant, instructing them to continuously chew it for 15 minutes; subsequently we collected saliva samples at the same intervals previously fixed. The following day the experiment was repeated, this time requesting the patients to chew as slow as possible for 15 minutes, and then new samples were collected.

The obtained results proved that the different concentrations observed in the 5 and 10 minute samples are due to individual gum chewing patterns. As showed in figure 4, different Fluoride concentrations are detected for the same subject when chewing slowly (pink line) and chewing continuously (blue line) at the 5 and 10 minute samples, respectively.

**Adults control group**

The results obtained by the analysis of saliva samples collected from the adults enrolled in the study, after fluoridated gum chewing, were the following.

The Fluoride concentrations in the sample collected before the gum chewing were, as expected, lower than the levels detectable by the instrument. Thus the values obtained after the subjects chewed were ascribed only to the Fluoride released by the chewing gums.

All the values obtained from the analysis of the samples collected at fixed intervals (5, 10, 20, 30, 45 and 60 minutes after gum chewing) were registered and the results are showed in figure 5 that represents the Fluoride clearance: the ion concentration lowers as time goes by.

The trend in figure 5 is comparable to the results obtained by other studies [Cagetti et al., 2002; Sjogren et al., 1993; Oztas et al., 2004]. We agree with them that the decrease of Fluoride concentration is due to an increased salivation consistent with gum chewing and swallowing individual patterns.

**Analysis of the results obtained with tablets**

**Children group**

The results obtained by the analysis of the saliva samples collected from the subjects, after the dissolution of Sodium Fluoride tablets 0.50 mg, were the following.

The Fluoride concentrations detected in the samples collected before the tablet was administered were lower than the detectable limit of the instrument; hence the values assessed after the subjects chewed were referred only to the Fluoride released by the tablet. The means of the results obtained in the samples collected at the fixed intervals (5, 10, 20, 30, 45 and 60 minutes after the tablet dissolution) are represented in figure 6.

From the graph representing the Fluoride salivary clearance it is apparent that the ion concentration lowers as time goes by.

Also in this case the decrease of Fluoride concentration, as for the chewing gums, is due to the individual salivation and swallowing patterns.

The standard deviation of the samples collected at 5 and 10 minutes after the dissolution of the tablets is represented by a shorter interval compared to the one detected for chewing gums, which further
demonstrates the influence of chewing on data variability.

Observations It must be noted that the Fluoride concentration assessed for the tablets in the collections performed at 5 and 10 minutes after dissolution is equal to 38 mg/l and 15 mg/l versus the 8 mg/l and 4 mg/l detected for the chewing gums, respectively. The explanation is suggested by reckoning that from the time the chewing gum was introduced into the subjects’ mouth to the first saliva collection 20 minutes went by (15 for the chewing of the gum and 5 minutes from the end of the chewing, before the first collection took place) during which the Fluoride present in the chewing gum was swallowed. For the tablets the timeframe between the introduction into the oral cavity and the first saliva collection was much shorter, no more than 6 minutes, subsequently the amount of swallowed Fluoride would be much lesser that the correspondent intake during gum chewing.

Discussion

Many studies related the use of Fluoride-based toothpastes, rinses, varnishes, chewing gums and tablets with the reduced caries incidence in selected subject groups, verifying that the administration of low doses of Fluoride for long periods is beneficial in caries prevention [Leverett et al., 1985; Marino et al., 2003].

The topical application of Fluoride induces remineralisation of small enamel and dentin lesions and such effect is achieved with low ion concentrations and it does not increase when the Fluoride concentration is higher [Lagerweij and Ten Cate, 2006]. Other researches aimed to understand if the administration of Fluoride during the prenatal period was a more valid method than the Fluoride application after birth and particularly during the pre- and post-eruptive periods. From those experiments it has been concluded that Fluoride administration during the prenatal period is of lesser importance [Roriz Fonteles et al., 2005] and it can offer only a partial and limited protection, since the decay is caused by frequent and prolonged acid challenges which the teeth will be exposed to after eruption, the period when Fluoride prophylaxis is important.

The results of our study highlight a similar Fluoride kinetic for the two administration vehicles used and reflect the results obtained by other authors [Cagetti et al., 2002; Sjogren et al., 1993; Oztas et al., 2004] whom we agree with in stating that the decrease of Fluoride concentration is due to an increase in salivation and to the individual swallowing patterns.

In our graphs is it evident a Fluoride concentration peak in the samples collected at 5 minutes from the end of the gum chewing and tablet dissolution. After the concentration peak is reached, induced by the higher amount of Fluoride released by the two vehicles during the initial stages of consumption (9 mg/l for the chewing gums and 36 mg/l for the tablets), a rapid drop in Fluoride concentration can be observed. Such decrement proceeds until the concentrations reach the values of approximately 2 mg/l and 5 mg/l at 30 minutes for the chewing gums and the tablets, respectively.

After 30 minutes the Fluoride concentration further decreases, but to a lesser extent, remaining almost constant until the last value was detected, 60 minutes from the end of the chewing and the tablet dissolution.

The different initial concentrations obtained from the two administration vehicles, equal to 8 and 38 mg/l for chewing gums and tablets, respectively, can be explained by the time frame comprised between the introduction of the chewing gum into the mouth and the first saliva collection. By then 20 minutes had already went by (15 minutes of chewing + 5 minutes from the end of it). During that period the Fluoride contained in the chewing gum was swallowed, while in the case of tablets the time frame between the introduction of the tablets into the mouth and the first saliva collection was much shorter (approximately 6 minutes), thus the amount of swallowed Fluoride would be lesser that the one ingested during gum chewing.

After the first results highlighted the presence of two distinct subgroups, another important factor emerged: the chewing pattern influenced the value of the salivary Fluoride concentrations after the first chewing gum was administered.

We concluded that, depending on the gum chewing
speed, fast or slow, the oral Fluoride concentration can be lower or higher, respectively. However, after 30 minutes from the end of the gum chewing the concentrations assume similar values, regardless of the speed of mastication. In our opinion, with equal concentrations of Fluoride in the chewing gum and tablet, the latter is more effective since the amount of Fluoride that the tablet can release varies only as a function of salivation and swallowing. For the chewing gum, instead, in addition to those two parameters, chewing is able to affect and increase the variability of the results.

Gum chewing can be considered a valid aid when the usual after-meal hygiene is not practical. During mastication, and thanks to the action of tongue and jaws, the saliva is pushed within the interproximal spaces providing a cleansing action and acting as a carrier for the Fluoride released by chewing gums. To better capitalise of the beneficial effect of gum chewing it is advisable to chew slowly in order to obtain a higher concentration of Fluoride for a prolonged time in the oral cavity.

Based upon these observations we can conclude that, agreeing with the studies we referred to in our research, both chewing gum and tablets are effective methods of Fluoride administration and they can be considered useful in dental caries prevention (when in conjunction with proper oral hygiene).

**Conclusion**

In the light of our findings, it is important to underline three factors.

1. The salivary clearance of Fluoride is similar for both the administration methods: in fact a gradual reduction of it has been noted in both cases.

2. The concentration of Fluoride, both released from chewing gum or tablets, is affected by individual factors such as salivation and swallowing patterns, which can influence the amount of Fluoride present in saliva.

3. Regarding the concentration of Fluoride released by chewing gum, besides salivation and swallowing, the type of mastication also plays a role. When the same subject chews the gum fast or slow, sample concentrations differ, lower and higher, respectively.

**References**


Ithagarun A, Wei SH. Chewing gum and saliva in oral health, J Clinical Dentisry 1997;8:159-162.


