Original Paper

Caries Research

Caries Res 2010;44:323–331
DOI: 10.1159/000317490

Received: November 24, 2009
Accepted after revision: April 28, 2010
Published online: July 3, 2010

# Preventive Effect of High-Fluoride Dentifrice (5,000 ppm) in Caries-Active Adolescents: A 2-Year Clinical Trial

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**Key Words**
Caries-active adolescents · Dental caries · High-fluoride dentifrice · Toothbrushing

**Abstract**
There is a lack of clinical studies comparing dentifrices with high fluoride (F) concentration. The aim was to evaluate a dentifrice containing 5,000 ppm F compared to a dentifrice containing 1,450 ppm F in caries-active adolescents. The design was a 2-year, single-blind randomized controlled trial and 211 adolescents of 279 (76%) completed the trial. The subjects were divided into two groups and were given one of the assigned F dentifrices for daily unsupervised toothbrushing: (1) Duraphat 5,000 ppm F and (2) Pepsodent Superfluor 1,450 ppm F, both as NaF. The outcome variables were caries incidence and progression of proximal and occlusal caries. The subjects were asked to fill in a questionnaire to evaluate their compliance and they were divided into two subgroups: subgroup A, excellent compliance, and subgroup B, poor compliance. The latter group (28%) comprised the subjects who did not brush twice a day or did not use the dentifrice regularly. Adolescents using 5,000 ppm F toothpaste had significantly lower progression of caries compared to those using 1,450 ppm F toothpaste (A: $p < 0.01$, B: $p < 0.001$), with a prevented fraction of 40%. Subjects using 5,000 ppm F toothpaste had significantly lower caries incidence for compliance B compared to those using 1,450 ppm F toothpaste ($p < 0.05$); the prevented fraction was 42%. This may indicate that 5,000 ppm F toothpaste has a greater impact on individuals who do not use toothpaste regularly or do not brush twice a day. Thus, 5,000 ppm F toothpaste appears to be an important vehicle for caries prevention and treatment of adolescents with a high caries risk.



The well-known reduction in caries during the last 30–40 years is primarily a result of the daily use of fluoride (F) dentifrices [Bratthall et al., 1996; Marinho et al., 2003]. Still, dental caries is a common disease among adolescents [Nithila et al., 1998; Marthaler, 2004] and affects 80% of 15-year-olds [Hugoson et al., 2005]. Furthermore, the Swedish Council on Technology Assessment in Health Care [SBU, 2002; Twetman et al., 2003] showed strong scientific evidence that the daily use of F toothpaste is an effective method for preventing dental caries in permanent teeth.

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Various factors influence the efficacy of F toothpaste and they include the F concentration, the amount of toothpaste applied to the brush, the frequency of brushing, brushing time, and post-brushing water rinsing [Davies et al., 2003; Zero et al., 2010]. The trend has been to increase the concentration of F in toothpaste. Dentifrices with 1,500 ppm F have a slightly better preventive effect (≈10%) compared with those with 1,000 ppm F [Twetman et al., 2003]. Several studies indicate that there is a linear (dose-response) relationship between the F concentration in toothpastes and caries reduction (up to 1,500 ppm) [Birkeland, 1972; White and Nancollas, 1990]. Within the range of 1,000–2,500 ppm F, an increase of around 500 ppm F in the paste resulted in an additional 6% reduction in dental caries [Stephen et al., 1988; O'Mullane et al., 1997]. According to a recent Cochrane report, the effect of F toothpaste appears to increase with a higher baseline DMFS level in the subjects, a higher F concentration in the paste and a higher frequency of use [Marinho et al., 2003].

In Sweden, the F concentration in dentifrices sold in normal shops varies between 400 and 1,500 ppm. Toothpaste with a higher concentration can only be obtained at a pharmacy as an over-the-counter product. Dentifrices with 2,800–5,000 ppm F have recently been introduced in several countries for patients with a high caries risk. Unfortunately, there are few clinical studies evaluating dentifrice with 5,000 ppm F [Tavss et al., 2003]. In one clinical study, a 5,000 ppm F gel was used every day in a similar way to toothpaste and the result was positive [Englander et al., 1967; Dreizen et al., 1977]. The reversal of root caries after using a dentifrice containing 5,000 ppm F has been shown by Baysan et al. [2001] and Ekstrand et al. [2008]. In a comparison of toothpastes containing 1,250, 2,500 and 5,000 ppm F in children, Cutress et al. [1992] demonstrated that after 3 years, the 5,000 ppm F toothpaste was significantly more effective in reducing caries than the lower concentrations. However, the field data proved unusable because of the method of scoring and the children located and re-examined 1 year later represented only 34% of the original randomized baseline subjects. In addition, only 756 of the originally 1,508 children completed the study. It would seem, therefore, that clinical studies comparing dentifrices with high F concentration are needed.

The aim of the present clinical study was to evaluate the preventive effect of a dentifrice containing 5,000 ppm F, compared with a standard dentifrice containing 1,450 ppm F (both as NaF), on caries-active adolescents.

## Subjects and Methods

*Subjects*

A total of 279 healthy volunteers (146 boys and 133 girls) were assigned to this single-blind randomized controlled trial. Subjects aged 14 (n = 112), 15 (n = 74) and 16 (n = 93) years (mean age 15) were assigned to the study and equally distributed in the two groups. The adolescents were recruited at the Public Dental Service Clinic in the city of Varberg, Sweden and they were all residents in the city. Varberg is a small town with one Public Dental Service Clinic, in which almost all adolescents receive their dental care. The 279 subjects were selected according to DMFS and divided randomly into two groups with 140 and 139 individuals, respectively. The inclusion criteria were DMFS ≥5 and the individuals were numbered consecutively from 1 to 279. Every even number was assigned to the test group and every odd number to the control group. Adolescents who did not want to participate and those with orthodontic appliances were excluded. The number of participants, the distribution of dentifrices, gender, age, dropouts and compliance and the flow of participants through each stage of the study are shown in figure 1. The concentration of F in the drinking water in Varberg is low (0.1 ppm). The study was approved by the Ethics Committee at Sahlgrenska Academy, University of Gothenburg (Dnr 289-04) and consent forms were obtained before starting the study.

*Dropouts*

Sixty-eight adolescents of 279 (24%) did not complete the study. The reasons for not completing were starting orthodontic treatment (n = 26), no wish to attend or to continue the study (n = 15), moving from the clinic (n = 11) and not attending their appointments (n = 11), while 4 subjects became seriously ill and 2 individuals were excluded as outliers (1 in each group). The result is therefore based on 211 adolescents. The distribution of dropouts and gender is presented in figure 1 and the baseline DFS data for the dropouts are shown in table 1.

*Study Design*

Each group was given one of the assigned dentifrices and toothbrushes for daily unsupervised toothbrushing for 2 years. The dentifrices were Duraphat 5,000 ppm F (Colgate-Palmolive AB, Danderyd, Sweden) and Pepsodent Superfluor 1,450 ppm F (Lever Fabergé, Stockholm, Sweden), both as NaF. The toothpastes are here called 5,000 ppm and 1,450 ppm toothpaste, respectively. Toothbrushes and dentifrices were delivered to their home address by post, every third month. The dentifrices could not be provided blindly from the manufacturer and consequently this study was only blinded to the observer. The recommended amount of toothpaste applied to the toothbrush was 1 g (≈2 cm) and the subjects were shown the optimal amount for both dentifrices. It was stressed that the paste should be used twice a day, i.e. after breakfast and just before bedtime. The adolescents and their parents were instructed to keep the 5,000 ppm dentifrice in a safe place for small children.

The volunteers were examined clinically by one and the same dentist (the principal investigator, A.N.) in a dental chair using optimal light, a mirror and an explorer. Digital bitewing radiographs were taken and the study was based on both clinical and radiographic examinations. The clinical criteria for detecting dental caries were based on the presence or absence of visible/

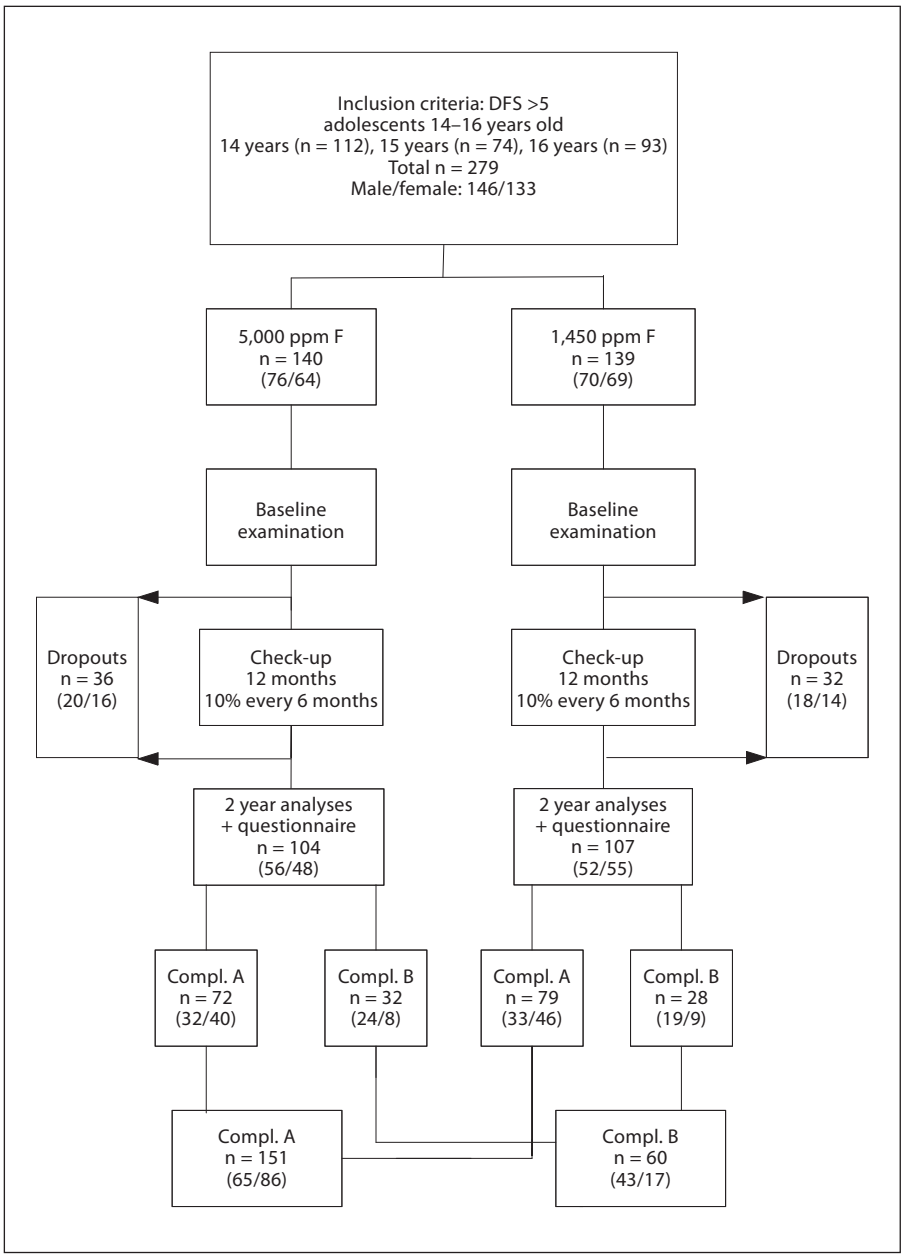


**Fig. 1.** Participants, distribution of dentifrices, gender, age, dropouts and compliance.

tactile cavitations. Evaluations were carried out after 2 years, with a new clinical examination and new bitewing radiographs. At the last appointment, the subjects were asked to fill in a questionnaire in order to evaluate their compliance. The adolescents were then divided into two subgroups according to their compliance: subgroup A, excellent compliance, and subgroup B, poor compliance. The latter group comprised subjects who did not use the toothpaste regularly or did not brush twice a day. The outcome variables were caries incidence, caries progression and prevented fraction (PF) of proximal and occlusal dental caries.

*Radiographic Analyses*

The bitewing radiographs were analysed blindly according to Gröndahl et al. [1977] by one of the authors (A.N.). The digital films were examined in a dark room with a computer and a special medical screen (Vistaline, Orolin AB, Kungsbacka, Sweden). The bitewings were generally of high quality and the proximal surfaces only overlapped in a few cases. Unreadable proximal surfaces were excluded. Before examining the films, the investigator consulted a specialist at the Department of Oral Radiology for calibration. A total of 44 proximal surfaces were scored, from the mesial surface of the second molar to the mesial surface of the first premolar, as well as the occlusal surfaces. In order to calculate

**Table 1.** Caries prevalence (mean ± SD) at baseline and after 2 years

| | Baseline | | | | After 2 years | | |
|---|---|---|---|---|---|---|---|
| | 5,000 ppm (n = 104) | 1,450 ppm (n = 107) | total (n = 211) | dropouts (n = 68) | 5,000 ppm (n = 104) | 1,450 ppm (n = 107) | total (n = 211) |
| DFS | 5.84 ± 4.23 | 5.83 ± 4.40 | 5.83 ± 4.31 | 5.78 ± 4.21 | 7.15 ± 4.69 | 7.49 ± 5.20 | 7.32 ± 4.95 |
| $D_iFS$ | 14.98 ± 6.23 | 15.37 ± 6.72 | 15.18 ± 6.47 | 12.90 ± 6.22 | 16.11 ± 6.32 | 16.56 ± 7.36 | 16.34 ± 6.85 |
| $DFS_o$ | 3.69 ± 2.59 | 3.54 ± 2.45 | 3.62 ± 2.50 | 3.85 ± 2.56 | 4.38 ± 2.62 | 4.27 ± 2.88 | 4.32 ± 2.75 |
| $DFS_a$ | 2.14 ± 2.26 | 2.29 ± 2.44 | 2.22 ± 2.35 | 1.93 ± 2.25 | 2.78 ± 2.59 | 3.21 ± 2.86 | 3.00 ± 2.73 |
| DS | 1.58 ± 1.65 | 1.41 ± 1.35 | 1.49 ± 1.50 | 1.49 ± 1.88 | 1.03 ± 1.16 | 1.34 ± 1.55 | 1.18 ± 1.38 |
| $DS_a$ | 0.99 ± 1.20 | 0.90 ± 1.17 | 0.94 ± 1.19 | 0.96 ± 1.34 | 0.91 ± 1.14 | 1.17 ± 1.42 | 1.04 ± 1.30 |
| $D_eS_a$ | 9.14 ± 4.22 | 9.54 ± 4.57 | 9.35 ± 4.39 | 7.12 ± 4.11 | 8.95 ± 4.20 | 9.07 ± 4.29 | 9.01 ± 4.24 |
| $DFS_a + D_eS_a$ | 11.29 ± 5.14 | 11.83 ± 5.34 | 11.56 ± 5.24 | 9.04 ± 4.82 | 11.73 ± 5.16 | 12.29 ± 5.52 | 12.01 ± 5.34 |

DFS = Decayed and filled surfaces; $D_iFS$ = decayed (enamel + dentine) and filled surfaces; $DFS_o$ = decayed and filled occlusal surfaces; $DFS_a$ = decayed and filled proximal surfaces; DS = decayed surfaces; $DS_a$ = proximal dentine lesions; $D_eS_a$ = proximal enamel lesions; $DFS_a + D_eS_a$ = total proximal caries score.

intra-examiner reproducibility, 10% of the radiographs were analysed twice, with an interval of 2 months.

Dental caries was registered on proximal surfaces as enamel caries (scores 1 and 2) or dentine caries (scores 3 and 4) and on occlusal surfaces as dentine caries (scores 3 and 4), as follows: 0 = caries-free; 1 = lesion in the outer half of the enamel; 2 = lesion more than halfway through the enamel but not passing the enamel-dentine junction; 3 = lesion with obvious spread in the outer half of the dentine; 4 = lesion with obvious spread in the inner half of the dentine; 5 = restored surface; 6 = unreadable surface, due to overlapped bitewing; 7 = secondary caries. All initially caries-free surfaces turning into an enamel or a dentine lesion or filling were defined as 'caries incidence': 0→1–5 (0→1, 0→2, 0→3, 0→4, 0→5). A change from grade 1 or 2 to grade 3 or 4, or to a filling, was defined as a 'progressed carious lesion': 1→2–5 (1→2, 1→3, 1→4, 1→5) and 2→3–5 (2→3, 2→4, 2→5). The treatment effect was expressed as PF, i.e. the difference in mean caries incidence and progression between dentifrices with 5,000 and 1,450 ppm F, expressed as a percentage of the incidence and progression in the 1,450 ppm F group [Kleinbaum et al., 1982].

*Intra-Examiner Reliability*

The intra-examiner reliability was based on the radiographic examinations and all adolescents were examined by one and the same dentist. The intra-examiner kappa value was 0.94 when the calculation included all scores (0–7) and 0.92 for carious surfaces (score 1–4) [Fleiss et al., 1979].

*Use of F Supplements*

All the subjects were treated with F varnish (Duraphat: Colgate, Piscataway, N.J., USA) once a year, at the yearly check-up. Adolescents in both groups with extremely high caries progression (≈10%; equally distributed in the two groups) were recalled every 6 months for a new radiographic check-up and were then treated with F varnish. The subjects were recommended to use no other F products than the supplied toothpaste during the 2 years.

*Statistical Methods*

The outcome measures were normally distributed. A power analysis with the assumptions significance level 5%, standard deviation 1.3, least detectable difference in incidence 0.6, and a power for that detection 90% was performed and a sample size of approximately 100 subjects in each group was suggested. Descriptive statistics, including means, standard deviations and frequency distributions, were calculated for the two dentifrices. The comparisons between the two dentifrices were tested using an unpaired two-sample t test and p values below 0.05 were considered statistically significant.

## Results

*Caries Prevalence*

The mean caries prevalence at baseline and after 2 years is presented in table 1. There were no statistically significant differences between the two dentifrices at baseline when it came to the number of proximal dentine lesions and the proximal fillings ($DFS_a$).

*Caries Incidence*

The total caries incidence $DFS_a + D_eS_a$ (0→1–5) and new enamel lesions $D_eS_a$ (0→1–2) are shown in table 2 and figure 2. Adolescents using the 5,000 ppm toothpaste had significantly lower caries incidence for compliance B compared to those using the 1,450 ppm toothpaste ($p < 0.05$). There were no other statistically significant differences, even though the tendency was the same, i.e. 5,000 ppm resulted in less caries than 1,450 ppm.

**Table 2.** Total and proximal caries incidence and progression after 2 years (mean ± SD, p values) for the two compliance groups (A = excellent, B = poor) and for the pooled group (A + B)

| | | Compliance A | p value | Compliance B | p value | Compliance A + B | p value |
|---|---|---|---|---|---|---|---|
| Total incidence | 5,000 ppm<br>1,450 ppm | 1.07 ± 1.16<br>1.25 ± 1.50 | 0.4160 | 1.21 ± 1.39<br>2.07 ± 1.82 | 0.0416* | 1.12 ± 1.23<br>1.46 ± 1.61 | 0.0855 |
| Proximal incidence | 5,000 ppm<br>1,450 ppm | 0.48 ± 0.88<br>0.58 ± 1.06 | 0.5486 | 0.42 ± 0.66<br>1.04 ± 1.29 | 0.0205* | 0.46 ± 0.81<br>0.69 ± 1.14 | 0.0929 |
| Total progression | 5,000 ppm<br>1,450 ppm | 1.14 ± 1.33<br>1.85 ± 1.90 | 0.0095** | 1.58 ± 1.79<br>2.96 ± 2.47 | 0.0145** | 1.28 ± 1.50<br>2.13 ± 2.10 | 0.0009*** |
| Proximal progression | 5,000 ppm<br>1,450 ppm | 1.14 ± 1.33<br>1.85 ± 1.90 | 0.0095** | 1.58 ± 1.79<br>2.96 ± 2.47 | 0.0145** | 1.28 ± 1.50<br>2.13 ± 2.10 | 0.0009*** |

*Caries Progression*

The total caries progression for enamel lesions that progressed to dentine lesions (1–2→3–5) is illustrated in table 2 and figure 2. Adolescents using the 5,000 ppm toothpaste had significantly lower progression of caries compared to subjects using the 1,450 ppm toothpaste, in both compliance A ($p < 0.01$) and B ($p < 0.001$).

*Prevented Fraction*

Table 3 shows the treatment effect, expressed as PF. Using the 5,000 ppm toothpaste had the best effect on caries progression for compliance B, with a PF of 47%. The corresponding value for incidence was 42%. The total PF (groups A + B) was 40% for progression and 23% for incidence.

*Gender Difference*

When both groups were pooled, there was no significant gender difference in caries incidence and progression. However, there was a difference in the distribution of boys and girls in the compliance groups, as shown in figure 1. There was a majority of girls (n = 86) in group A compared with boys (n = 65) and twice as many boys (n = 43) as girls (n = 17) in group B.

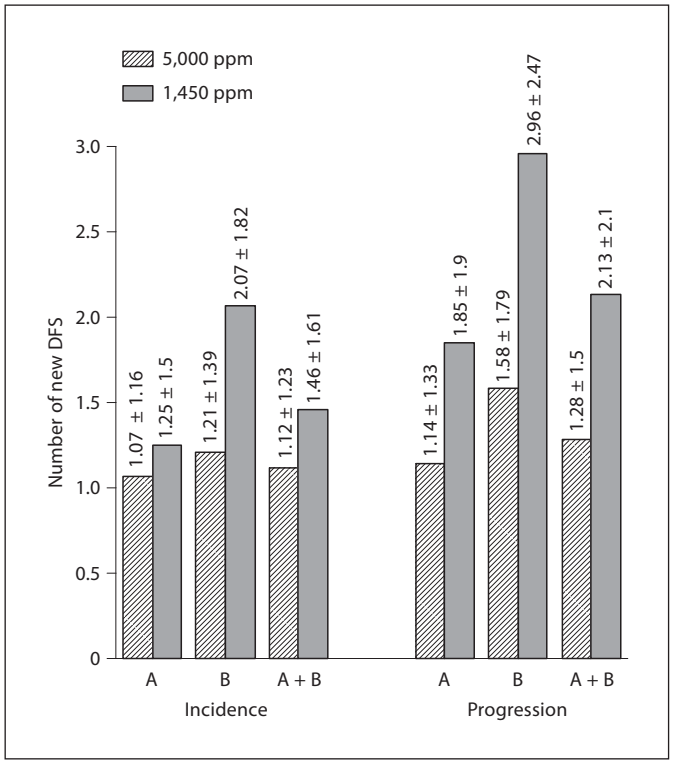


**Fig. 2.** Total caries incidence and progression after 2 years (mean ± SD) for the two compliance groups (A = excellent compliance, B = poor compliance) and for the pooled group (A + B). Adolescents using 5,000 ppm toothpaste had significantly lower progression of caries compared to those using 1,450 ppm toothpaste (A: $p < 0.01$, B: $p < 0.001$). Subjects using 5,000 ppm F toothpaste had a significantly lower caries incidence for compliance B compared to those using 1,450 ppm F toothpaste ($p < 0.05$).

## Discussion

The main result in the present study was that adolescents using the 5,000 ppm toothpaste had significantly lower progression of caries compared to subjects using the 1,450 ppm toothpaste after 2 years, disregarding compliance. The 5,000 ppm toothpaste produced significant-

**Table 3.** The treatment effect expressed as the PF, i.e. the difference in mean caries incidence and progression between dentifrices with 5,000 and 1,450 ppm F, expressed as a percentage of the incidence and progression in the 1,450 ppm F group

| | Compliance A 5,000 ppm (n = 71) | Compliance B 5,000 ppm (n = 33) | Compliance A + B 5,000 ppm (n = 104) |
|---|---|---|---|
| Incidence | 14% | 42% | 23% |
| Progression | 38% | 47% | 40% |

ly lower caries incidence in compliance B (poor compliance) compared to the 1,450 ppm toothpaste. This may indicate that high-F toothpaste has a greater impact on adolescents who do not use toothpaste regularly or do not brush twice a day.

As mentioned in the introduction, various factors influence the efficacy of F toothpaste and they include the F concentration, frequency of use, amount used, and rinsing behaviour. In accordance with earlier findings, it was observed that adolescents with high caries risk do not brush their teeth every day, and especially not twice a day. Two independent studies by Klock et al. [1989] and Koivusilta et al. [2003] concluded that 25% of 14-year-old adolescents do not use toothpaste regularly. Hugoson et al. [1995] found that the percentage of 15-year-old adolescents who brushed their teeth twice a day had decreased from 89 to 78% between 1983 and 1993. During the same period, the percentage of 15-year-olds who brushed 'every now and then' had increased from 1 to 5%. In three separate 3-year clinical trials, the caries increment in subjects who brushed once a day was 20–30% higher than it was in those who brushed twice a day [Chesters et al., 1992; O'Mullane et al., 1997; Chestnutt et al., 1998]. In the present study, we found that 60 subjects (28%) had poor compliance. The group comprised individuals who did not brush twice a day or did not use the dentifrice regularly. In addition, there were twice as many boys as girls in this group and the adolescents most commonly 'forgot to brush their teeth in the evening' (49%).

The amount of toothpaste applied to the toothbrush affects the F concentration in saliva and plaque. One study demonstrated that the mean F salivary levels after brushing with 0.25 g of toothpaste were approximately one third of those obtained after brushing with 1.0 g of toothpaste [DenBesten and Ko, 1996]. However, Duckworth et al. [1989] found a correlation between the F concentration in the plaque and an increasing F concentration in the dentifrices, but no correlation was found between the plaque F concentration and the amount of dentifrice used per application. The volunteers were properly instructed to use 1 g of the assigned dentifrice for toothbrushing. However, the tube of the 5,000 ppm F dentifrice has a smaller orifice and the amount of the applied toothpaste could easily be too small, even if this was stressed to the subjects at the start of the study.

Post-brushing water rinsing reduces the retention of F in the proximal area. Seventy-one percent of adolescents brushing with 5,000 ppm toothpaste rinsed with water after toothbrushing (compliance A = 69%, compliance B = 74%) and 76% of those brushing with 1,450 ppm (compliance A = 74%, compliance B = 83%). Duckworth and Morgan [1991] and Sjögren and Birkhed [1993] observed an increase in F concentrations in saliva when the frequency and the amount of rinsing water were reduced. In clinical trials, individuals who rinsed with large volumes of water had higher caries increments than those using smaller volumes [Chesters et al., 1992; O'Mullane et al., 1997; Chestnutt et al., 1998]. In a recent study, we concluded that 5,000 ppm F toothpaste without post-brushing water rinsing resulted in the highest F concentration in both plaque and saliva while 1,450 ppm F toothpaste with rinsing resulted in the lowest concentration [Nordström and Birkhed, 2009]. Post-brushing water rinsing after using 5,000 ppm toothpaste reduced the F concentration in saliva 2.4 times. However, in the present study there was no significant difference in caries increments between those who rinsed and those who did not rinse with water after toothbrushing.

Enamel caries lesions account for more than 80% of the total caries prevalence [Sköld et al., 1995]. In a systematic review, Pitts [1983] concluded that for the majority of individuals, the progression of small proximal caries lesions is a slow process, with a large number of lesions remaining unchanged for long periods, and this was also confirmed by Mejàre et al. [1999]. The medium survival time for proximal enamel lesions among Swedish adolescents in the 1990s was >5 years, while the corresponding figure for dentine lesions was 3.2 years, with a higher progression rate during the period of 14–16 years compared

with 16–19 years [Gustafsson et al., 2000]. According to the slow progression rate of proximal caries among Swedish adolescents, one may question the used experimental period of 2 years. However, from an ethical point of view, it is preferable to use a short experimental period. At this time point, adolescents are graduating from school and they are moving from the city of Varberg in order to study elsewhere. Another year of observation might have increased the dropouts. According to Chesters et al. [2002], the length of clinical studies could be reduced from the conventional 3 years to 2 years. In addition, Stookey et al. [2004] reported a difference in caries increment between toothpaste containing 1,100 and 2,500 ppm F after 2 years.

From an ethical point of view, it was necessary to provide caries prevention strategies for patients with a high caries risk. The clinical routine was to provide adolescents with F varnish once a year at the yearly examination. Subjects with extremely high caries progression (≈10%) were recalled every 6 months for new radiographs and a second F application. According to Zimmer [2001], the application of F varnish (Duraphath) twice a year produces a caries inhibition rate of about 38% with the simultaneous use of dentifrice. The PF for 5,000 ppm toothpaste may have been larger if the application of F varnish 1–2 times per year had been excluded. However, this was not possible from an ethical point of view.

Digital radiographs are in some respects more difficult to perform compared to conventional x-rays, especially in young patients. The film holders are harder and thicker, and it is easy to miss the distal surfaces of the canines in the upper jaw and especially in the lower jaw. In the present study, we therefore decided to exclude the distal surfaces of the canines. In a clinical study, Martignon et al. [2006] evaluated the efficacy of sealing proximal active lesions by using both conventional and subtraction radiographs. They concluded that subtraction radiography appeared to be the most sensitive method for assessing lesion progression. This method could have been used in the present study if the technique had been available at the start of the trial in 2003.

Children under 16 years should not use toothpaste with 5,000 ppm F according to the instructions given by the manufacturer. Perhaps the age of 12 years would be a more appropriate age limit, in order to protect the newly erupted premolars and second molars and since there is no risk of fluorosis beyond this age. Approximately 5–10% of a dentifrice is swallowed during brushing when using a minimum amount of water [Sjögren and Birkhed, 1994]. The amount of swallowed F is therefore 0.25–0.50 mg F when using 1 g of a toothpaste containing 5 mg F/g. This quantity corresponds to the amount of F in 1–2 F tablets containing 0.25 mg F and is considered to have no toxic effect in teenagers and adults. However, it is important to keep the 5,000 ppm dentifrice in a safe place for small children.

Sixty-eight adolescents (24%) did not complete the present study. The distribution of dropouts between the two dentifrices was similar: 36 adolescents dropped out from the 5,000 ppm toothpaste and 32 from the 1,450 ppm toothpaste. However, there were more boys than girls among the dropouts (38 vs. 30). The most common reasons were that the subjects had begun orthodontic treatment, did not wish to participate in the study or had moved from the area. Adolescents with a high caries risk are not easy to manage, as they miss their appointments more frequently, and 11 subjects were excluded for this reason.

Adults and teenagers with a high caries risk constitute a suitable target group for using a dentifrice with 5,000 ppm F. Adolescents in particular run a certain caries risk when their teeth have just erupted. A high-F dentifrice has also been recommended for optimal caries prevention strategies during orthodontic treatment [Derks et al., 2004]. Elderly subjects with hyposalivation due to medication or radiation are another interesting group to keep in mind. The reversal of root caries has already been documented by Baysan et al. [2001] and Ekstrand et al. [2008], using a toothpaste with 5,000 ppm F.

To conclude, caries-active adolescents using the 5,000 ppm toothpaste had significantly lower progression of caries compared to subjects using the 1,450 ppm toothpaste after 2 years. We found that 60 subjects (28%) had poor compliance. This group comprised subjects who did not brush twice a day or did not use the dentifrice regularly and included twice as many boys as girls. In addition, the caries incidence in the 'poor compliance' group was significantly lower for subjects who used the 5,000 ppm F toothpaste. The data may indicate that 5,000 ppm toothpaste has a greater impact on individuals who do not use toothpaste regularly or do not brush twice a day. The 5,000 ppm toothpaste therefore appears to be an important vehicle for the treatment and prevention of caries in patients with a high caries risk. However, when it comes to preventing caries in adolescents with a high caries risk, one challenge is motivating them to use toothpaste regularly, at least twice a day.

## Acknowledgements

We gratefully acknowledge the clinical assistance of Clovis Kastberg, Agneta Persson and Lily-Ann Rosdahl at the Public Dental Service Clinic in Varberg and the statistical assistance by Tommy Johnsson. This study was supported by grants from the Region of Halland and the Institute of Odontology, University of Gothenburg. The 5,000 ppm and 1,450 ppm toothpastes and the toothbrushes were free of charge and supplied by Colgate.

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