Chlorhexidine and the control of plaque and gingivitis
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Chapter 2

Influence of an SLS-containing dentifrice on the anti-plaque efficacy of a chlorhexidine mouthrinse

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Introduction

In order to prevent and control periodontal disease, mechanical removal of plaque by toothbrushing with a dentifrice appears to be the most practical and cost-effective method for supra-gingival plaque control, for most individuals (Löe et al. 1965, Frandsen 1986). However, in areas where toothbrushing is difficult, compromised or even impossible, chemical plaque control may be justified (Addy 1986, Addy & Moran 1997). One of the best studied anti-microbial agents for chemical plaque control is chlorhexidine. After almost 35 years of use by the dental profession, chlorhexidine is considered as “the gold standard” against which other anti-plaque and gingivitis agents are measured (Löe & Schiött 1970, Addy 1986, Hull 1980, Korman 1986, Lang & Brecx 1986, Mandel 1988, Gjermo 1989, Addy et al. 1992).

In the absence of mechanical tooth cleaning, rinsing for 60 seconds twice daily with 10 ml of a 0.2% chlorhexidine digluconate solution reduces the accumulation of plaque by approximately 60% and the severity of gingivitis by 50-80% (Löe & Schiött 1970). The success of CHX is due to its bactericidal and bacteriostatic activity (Denton 1991) and based on its high intra-oral substantivity. This characteristic may be important for its efficacy and safety but, unfortunately, it is also the cause of local side effects.

Generally CHX is considered as an adjunct to mechanical oral hygiene and used before or after toothbrushing with dentifrice, especially during initial therapy and healing following periodontal surgery. Nowadays, the most widely used detergent in dentifrice is sodium lauryl sulfate (SLS). Unfortunately, CHX and SLS can act as antagonists. The mode of action is based on the ionic attraction of CHX, a cationic bisbiguanide symmetrical molecule, to SLS, a molecule with anionic nature and high affinity for protein molecules.

In vitro, data have shown, indeed, that CHX is not compatible with SLS in an aqueous solution (Bonesvoll 1977) and that CHX forms salts of low solubility with anions such as phosphate, sulfate and carboxyl (Kirkegaard et al. 1974, Rölla et al. 1970, Rölla & Melsen 1975, Barkvoll et al. 1988).

In vivo, the interference of an aqueous solution of SLS with CHX was investigated by Barkvoll et al. (1989) and Owens et al. (1997). They concluded that the efficacy of a CHX rinse was significantly reduced in the environment of SLS, even when these compounds were introduced separately in the oral cavity.

Ever since, it has been recommended that the time between a CHX rinsing and toothbrushing with an SLS containing dentifrice should at least be 30 minutes, if reduction in the anti-microbial effect is to be avoided. To optimize the efficacy of a CHX rinse, toothbrushing should be performed using no dentifrice or a dentifrice without antagonistic ingredients.
However, to date no study has been conducted where the activity of a CHX mouthrinse is considered under the influence of ordinary toothbrushing with an SLS-containing dentifrice. The purpose of the present study was to investigate the effect of toothbrushing with an SLS containing dentifrice in one jaw, on the plaque inhibition of a 0.2% chlorhexidine mouthrinse in the opposite jaw during a 4-day study period.

Materials and methods

Subjects
16 volunteers, aged between 24 - 29 years were enrolled as potential participants. According to the inclusion criteria, all of them were found to be suitable for the study. They were in good general health without a medical history or medication that might interfere with the outcome of the study. All the subjects were dentate with at least 24 scoratable teeth. They were excluded if they had fixed or removable orthodontic appliances or removable prosthesis, pockets > 5 mm or attachment loss > 2 mm. After thorough explanation of the procedures, an informed consent was signed.

Procedure
The study was based on the 4-day plaque accumulation model initially developed to compare the chemical plaque inhibitory properties of dentifrices (Addy et al. 1983).

It was a single-blind, randomized, 2-cell, crossover design. It compared an oral hygiene regimen of a combination of brushing and rinsing with a regimen of rinsing alone. A washout of 17 days was inserted between the two crossover periods.

At baseline (day 1) of each test period all subjects received a thorough dental prophylaxis to remove all stain, calculus and plaque. Subjects were randomly assigned to one of the 2 regimens. Instructions for the allocated regimen were given to each subject in a sealed envelope.

One jaw (upper or lower) was randomly assigned as the “study” jaw (figure 1) while the opposite jaw served to introduce the effect of toothbrushing with a dentifrice in the same mouth. This opposite jaw is referred to as the “dentifrice” jaw. The “study” jaw was used to evaluate the level of plaque accumulation at the end of each 4-day period.
The following 2 regimens were designed:

- **Regimen 1: CHX rinsing preceded by toothbrushing with a 1.5% SLS-containing dentifrice**
  Twice daily the subjects brushed with an SLS containing dentifrice (Colgate-Bi-Fluor®; Colgate Palmolive)* in one randomly assigned “dentifrice” jaw (upper or lower), which served to introduce the effect of a dentifrice in the study model. After brushing, the dentifrice foam was expectorated and the oral cavity was rinsed with water. Immediately afterwards the subjects rinsed with 10 ml chlorhexidine digluconate 0.2% solution (Corsodyl®; GSK) during 60 seconds.

- **Regimen 2: CHX rinsing only**
  Twice daily the subjects rinsed with 10 ml chlorhexidine digluconate 0.2% solution (Corsodyl®, GSK) during 60 seconds. No brushing was allowed. This regimen was considered as the control period.

During both experimental regimens all other oral hygiene procedures were suspended. To check for compliance each participant was asked to write down the exact time of the two rinsing moments, in the morning and in the evening. Furthermore, it was not allowed to eat or to rinse with water for 30 minutes after the assigned hygiene procedure.

After 4 days, plaque was scored in the “study” jaw. The plaque level was assessed at 6 sites around each tooth, according to the criteria of the Silness & Löe plaque index (1964), modified as described by Van der Weijden et al. (1993). During the washout period, subjects resumed their normal tooth cleaning habits. All clinical measurements were performed by one and the same blinded examiner (SS) under the same conditions.

* Colgate-Bi-Fluor® contains dicalcium phosphate dihydrate, aqua, glycerin, sorbitol, sodium lauryl sulfate, aroma, sodium monofluorophosphate, cellulose gum, hydroxyethylcellulose, tetrasodium pyrophosphate, sodium saccharin, sodium fluoride.

**Data analysis**
Mean plaque scores were calculated. In addition, plaque scores were calculated for the different tooth-types (anterior and molar teeth) and different tooth surfaces (buccal and lingual). Wilcoxon tests were used to test for differences between the 2 treatments within subjects over the 2 experimental periods. $p$-values $< 0.05$ were considered statistically significant.
Results

All the selected subjects (n=16) completed the study without protocol violation.

Table 1 shows the mean plaque-scores of the “study” jaws for rinsing with chlorhexidine preceded by toothbrushing of the opposite “dentifrice” jaw with a 1.5% SLS containing dentifrice (regimen 1) and for rinsing with 0.2% chlorhexidine alone (regimen 2). The mean plaque index for the brushing & rinsing regimen was 0.36 and for the rinsing only regimen was 0.34. Statistical analysis showed no significant difference in overall plaque score between both regimens.

Furthermore table 1 shows the mean plaque-score for the different regions of interest. On the buccal sites more plaque was present than on the lingual (p < 0.05). This was irrespective of the regimens. No differences were observed between anterior teeth and molar teeth.

Table 1. Mean overall plaque scores for each regimen after 4 days of plaque accumulation, standard deviation in parenthesis.

<table>
<thead>
<tr>
<th>Plaque Index</th>
<th>Regimen 1</th>
<th>Regimen 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>overall</td>
<td>0.36 (0.3)</td>
<td>0.34 (0.2)</td>
</tr>
<tr>
<td>buccal</td>
<td>0.41 (0.4)</td>
<td>0.39 (0.2)</td>
</tr>
<tr>
<td>lingual</td>
<td>0.31 (0.3)</td>
<td>0.29 (0.2)</td>
</tr>
<tr>
<td>front area</td>
<td>0.35 (0.4)</td>
<td>0.30 (0.2)</td>
</tr>
<tr>
<td>molar area</td>
<td>0.37 (0.3)</td>
<td>0.37 (0.2)</td>
</tr>
</tbody>
</table>

Regimen 1: CHX rinsing preceded by toothbrushing with an SLS containing dentifrice.
Regimen 2: CHX alone.

CHX, chlorhexidine digluconate; SLS, sodium lauryl sulphate.

Discussion

The aim of the present study was to investigate the plaque inhibitory effect of a 0.2% CHX rinse when preceded by toothbrushing with an SLS-containing dentifrice in the opposite jaw. Previous studies (Barkvoll et al. 1989, Owens et al. 1997) have shown that CHX and SLS are not compatible even when they are introduced separately in the oral cavity. Based on the ionic attraction between both agents, it is feasible to accept that a salt with low solubility and low
antibacterial activity is formed, neutralizing CHX. Either toothbrushing with dentifrice should be suspended or toothbrushing should be performed without dentifrice or with dentifrice formulations without antagonistic ingredients (Owens et al. 1997).

From earlier interaction studies with CHX (Dolles et al. 1979, Barkvoll et al. 1989, Owens et al. 1997), it was expected that SLS would reduce the CHX activity whether used before or after the antiseptic. The study of Barkvoll et al. (1989) provided plaque data both for an aqueous solution of SLS used “before” and “after” rinsing with CHX. Owens et al. (1997) studied the effect of rinsing with an SLS containing slurry, used immediately before and immediately after the CHX. From their results it was apparent that the anionic SLS ingredient of the dentifrice slurry had adverse effects on the CHX activity, irrespective of whether the slurry was used before or after the rinse. Whatever the mechanism, CHX was found to be most effective when used without the presence of SLS. For the present study it was chosen to use the SLS containing dentifrice and the chlorhexidine mouthrinse in an ordinary order. First, the teeth were brushed using a toothbrush and dentifrice followed by rinsing with water. Subsequently subjects rinsed with CHX. Using this order, the plaque inhibiting capacity of CHX appeared not to be reduced in an environment of an SLS containing dentifrice used prior to the rinsing procedure.

The results of the present study, showing no inhibitory effect of SLS on the efficacy of CHX, do not support the conclusions of the previous studies. When trying to explain the disagreement in results of the present study and those of Barkvoll et al. (1989) and Owens et al. (1997), several differences in study design can be brought forward. Barkvoll et al. (1989) used a relatively small sample of subjects (N=7). The influence of SLS was introduced by pre-rinsing with an aqueous solution of 0.2% SLS. Owens et al. (1997) converted an SLS containing dentifrice (Colgate/Colgate Palmolive®) into a 3 g/10 ml water slurry which was also used as a rinse. These studies may overestimate the influence of an SLS containing dentifrice on the activity of CHX in a “real life” situation. Ordinary oral hygiene procedures involve a toothbrush and dentifrice to brush the teeth after which the dentifrice foam is expectorated and the oral cavity is rinsed with water. Following such a procedure the interaction between CHX and SLS is probably minimal because most of the effects of the dentifrice ingredients are eliminated (Sjögren & Birkhed 1994). Unlike the Owens study (1997) the assigned regimens in the present study were performed without supervision. However, the panelists were requested to fill out a rinsing diary to stimulate their compliance. The returned diaries indicated that the panelists followed the given instructions conscientiously.
SLS from different dentifrices may not be present in equal concentrations or be equally available in the formula. The SLS-concentration of the dentifrice used (Colgate-Bi-Fluor®) was 1.5%. Other brands of dentifrices may have yielded another result. The influence of dentifrices with different SLS-concentrations may be a valuable challenge of further research. In conclusion, within the limitations of the present study design, it can be concluded that ordinary brushing with a 1.5% SLS containing dentifrice (Colgate-Bi-Fluor®), followed by rinsing with water does not appear to reduce the level of plaque inhibition offered by a post-brushing 0.2% chlorhexidine rinse.
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References


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