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

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Abstract

Background: Chlorhexidine (CHX) and sodium lauryl sulphate (SLS), the most widely used detergent in dentifrice, may counteract. Consequently, studies about this interaction suggested that care is required when combining both these compounds, even when they are introduced separately into the oral cavity. The purpose of the present study was to investigate the effect of toothbrushing with a SLS-containing dentifrice in one jaw, on the plaque inhibition of a CHX mouthrinse in the opposite jaw during a 4-day study period.

Methods: The study was an examiner-blind, randomised two-cell, crossover design. It used a 4-day plaque accumulation model to compare two different oral hygiene regimens with a washout period of 17 days. Sixteen healthy volunteers were enrolled in the study and received a thorough dental prophylaxis at the beginning of each 4-day test period. One jaw (upper or lower) was randomly assigned as the ''*study*'' jaw. The opposite jaw was assigned as the ''*dentifrice*'' jaw and served only to introduce the effect of brushing with a dentifrice in the study model. Two oral hygiene regimens were evaluated. During one randomly assigned test period, the ''*dentifrice*'' jaw was treated by toothbrushing with a 1.5% SLS-containing dentifrice and rinsed together with the ''*study*'' jaw with 0.2% CHX, thus forming regimen 1. As a control during the other test period, both the ''*dentifrice*'' jaw and ''*study*'' jaw were only rinsed with 0.2% CHX, forming regimen 2. No other oral hygiene methods were allowed. After 4 days of undisturbed plaque accumulation, the amount of plaque was evaluated (Silness & Löe 1964). The ''*study*'' jaw was used to study the effect of the two regimens on the level of plaque accumulation at the end of the 4-day period.

Results: The overall plaque index was 0.36 for regimen 1 and 0.34 for regimen 2. There was no significant difference in plaque accumulation between the two regimens.

Conclusions: 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 CHX rinse.

Key words: chlorhexidine; dentifrice; plaque; sodium lauryl sulphate

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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 supragingival 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 1997a). One of the best-studied anti-microbial agents for chemical plaque control is chlorhexidine (CHX). After almost 35 years of use by the dental profession, CHX is considered as ''the gold standard'' against which other anti-plaque and gingivitis agents are measured (Löe & Schiott 1970, Hull 1980, Addy 1986, Kornman 1986, Lang & Brecx 1986,

Mandel 1988, Gjermo 1989, Addy et al. 1992). In the absence of mechanical toothcleaning, rinsing for 60 s twice daily with 10 ml of a 0.2% CHX digluconate solution reduces the accumulation of plaque by approximately 60% and the severity of gingivitis by 50–80% (Löe & Schiott 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 sulphate (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 an 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, sulphate and carboxyl (Rølla et al. 1970, Kirkegaard et al. 1974, Rølla & 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 a SLS-containing dentifrice should at least be 30 min, if reduction in the anti-microbial effect is to be avoided. To optimise 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 a SLS-containing dentifrice. The purpose of the present study was to investigate the effect of toothbrushing with a SLS-containing dentifrice in one jaw, on the plaque inhibition of a 0.2% CHX mouthrinse in the opposite jaw during a 4-day study period.

Material and Methods

Subjects

Sixteen volunteers, aged between 24 and 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 scorable teeth. They were excluded if they had fixed or removable orthodontic appliances or removable prosthesis, pockets >5 mm or attachment loss >2 mm. After a thorough explanation of the procedures, an informed consent was signed.

Procedure

Method

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, randomised, two-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 the 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 two 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, 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 two regimens were designed:

- *Regimen 1: CHX rinsing preceded by toothbrushing with a 1.5% SLS-containing dentifrice.* Twice daily, the subjects brushed with a SLS-containing dentifrice (Colgate-Bi-Fluor®; Colgate Palmolive, Weesp, The Netherlands) 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 CHX digluconate 0.2% solution (Corsodyl®; GlaxoSmithKline, Zeist, The Netherlands) during 60 s. (Colgate-Bi-Fluor contains dicalcium phosphate dihydrate, aqua, glycerin, sorbitol, SLS, aroma, sodium monofluorophosphate, cellulose gum, hydroxyethylcellulose, tetrasodium pyrophosphate, sodium saccharin and sodium fluoride.)
- *Regimen 2: CHX rinsing only.* Twice daily, the subjects rinsed with 10 ml CHX digluconate 0.2% solution (Corsodyl®, GlaxoSmithKline) during 60 s. 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, eating or rinsing with water for 30 min after the assigned hygiene procedure was not allowed.

After 4 days, plaque was scored in the ''*study*'' jaw. The plaque level was assessed at six 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.

Data analyses

The 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's tests were used to test for differences between the two treatments within subjects over the two experimental periods. p-values < 0.05 were considered as 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 CHX preceded by toothbrushing of the opposite ''*dentifrice*'' jaw with a 1.5% SLS-containing dentifrice (regimen 1) and for rinsing with 0.2% CHX alone (regimen 2). The mean plaque index for the brushing and rinsing regimen was 0.36 and for the rinsing-only regimen, it was 0.34. Statistical analysis showed no significant difference in the 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.

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 a 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 anti-bacterial activity is formed, neutralising 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).

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

Plaque index	Regimen 1	Regimen 2
overall	0.36 (0.3)	0.34 (0.2)
buccal	0.41 (0.4)	0.39 (0.2)
lingual	0.31 (0.3)	0.29 (0.2)
front area	0.35 (0.4)	0.30 (0.2)
molar area	0.37 (0.3)	0.37 (0.2)

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

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 a 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 CHX 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 a 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 the 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) 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% CHX rinse.

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