The effects of stannous and stannic ions on the formation and acidogenicity of dental plaque *in vivo*

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The present study was concerned with the effect of stannous and stannic ions on the formation and acidogenicity of dental plaque *in vivo*. Five dental students participated in the study on inhibition of plaque formation. They rinsed for four days with 0.2 % aqueous solution of either Sn^{2+} or Sn^{4+} and in addition 15 % w/v sucrose to enhance plaque formation. The P.I. was recorded after each series. Another test panel participated in the study on inhibition of acid production. The pH of the plaque was measured *in situ*. The stannous ion showed marked inhibiting activity on plaque formation whereas the stannic ion showed only a slight effect. The stannous ion also showed an effect in reducing the acidogenicity of dental plaque whereas the stannic ion showed no such effect. These findings support the concept that the stannous ion reduces the metabolic activity of plaque by oxidation of thiol groups by affinity for these groups. This is not the case with stannic ions. It seems conceivable that the reduced metabolic activity in plaque is the main factor which causes plaque inhibition. The slight plaque inhibiting effect of the stannic ions may be caused by inhibition of adsorption *as such* as this ion has no direct effect on the metabolism of the plaque.

Key-words: Preventive dentistry; dental plaque inhibition; clinical study

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It has been shown by several authors (3, 4, 12, 13, 14, 15) that stannous fluoride applied in the oral cavity as toothpastes or mouthrinses reduces the acidogenicity of plaque and also exerts a plaque inhibiting activity.

Recent research has shown that also silver and copper ions have activities similar to tin and that the effects on the metabolic activity of plaque by all these ions can be reversed by addition of monothiols. This indicates that an oxidation of thiol-containing enzymes in the glycolysis is probably the mechanism involved (8).

The aim of the present study was to compare the relative effects of the stannous and stannic ions on formation and acidogenicity of dental plaque.

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MATERIALS AND METHODS

Five dental students volunteered for three experimental series on inhibition of plaque formation. The students had a thorough prophylaxis before each series started. The test periods were four days and all mechanical oral hygiene measures were suspended during these periods. In addition the students rinsed eight times daily with 10 ml of a sucrose solution for one minute to enhance plaque formation.

In the first series 10 ml of distilled water was applied as a mouthrinse twice daily in order to obtain base line data for the plaque scores in the presence of sucrose. In the next series the students rinsed twice daily with a 0.2 per cent freshly made aqueous stannous fluoride solution. For the last series a solution of freshly made 0.2 per cent aqueous stannic chloride was used. The Plaque Index as described by Löe was recorded after each series (5).

Three dental students volunteered for a study concerning the effect of stannous and stannic ions on the acidogenicity of dental plaque. All mechanical oral hygiene measures were suspended three days prior to the experiment, and for these three days the students rinsed with a sucrose solution as described above. The pH of the plaque was measured *in situ* on two different teeth after topical application of sucrose prior to and ten minutes, two and seven hours after rinsing with the test solution. The pH was measured using an Ingold flat surface glass electrode, model 203–M3, connected to a Radiometer PHM Portable pH meter which has proved to be a reliable instrument for measuring the acidogenicity of dental plaque (13).

Statistical significance of the results was tested by an analysis of variance employing a pooled standard deviation (2).

RESULTS

Effects on plaque formation

The control group which rinsed with distilled water had a mean P1.I. of 1.71 whereas the stannous fluoride and stannic chloride yielded indices of values of 0.35 and 1.33 respectively (Table 1). The differences in P1.I. values between the placebo group and the two experimental groups were both statistically significant $p < 0.05$. The difference between the groups using the stannous and the stannic ions was also statistically significant. The plaque inhibiting effect of the stannic ion was rater inconspicuous compared with that of the stannous ion.

Effects on acidogenicity

Stannous ions showed a marked effect in reducing the acidogenicity of dental plaque. The effect could be demonstrated up to seven hours after a mouthrinse with stannous ions.

Stannic ions on the other side showed no effect on acid production in plaque. A Δ pH of 1.82 was observed already 10 minutes after a mouthrinse and this was not significantly different from the placebo group. The results are given in Fig. 1.

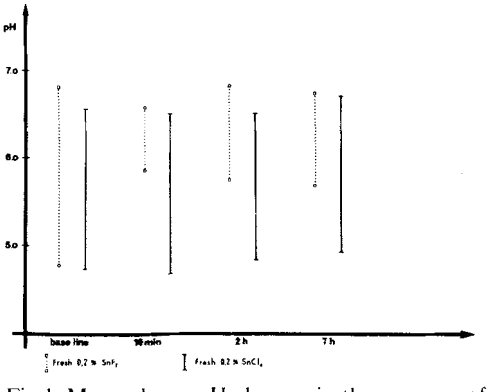

Fig 1. Mean plaque pH changes in the presence of sucrose, before (base line) and at given time intervals after rinsing with 10 ml fresh 0.2 per cent stannous fluoride or 10 ml fresh 0.2 per cent stannic chloride. n = 3

Table 1. *Mean plaque index after rinsing twice a day with either a fresh 0.2 per cent stannous fluoride solution or a fresh 0.2 per cent stannic chloride solution. Plaque formation was enhanced by addition of 15 per cent w/v sucrose solution eight times daily in both studies*

Control	w/sucrose	0.2 % fresh	SnF_2	0.2 % fresh	$SnCl_4$
$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
1.71	0.15	0.35	0.24	1.33	0.15

DISCUSSION

The previously reported effect of stannous fluoride on formation and acidogenicity of dental plaque (3, 4, 12, 13, 14, 15) was confirmed in the present study. The stannic ion showed, on the other side only a slight effect on plaque formation, and no effect on the metabolism judged by measurements of acid production in plaque after sucrose challenges as described above. These findings support the concept suggested by Oppermann and Rölla (1980) and Oppermann et al. (1980) that the stannous ion reduces the metabolic activity of plaque by oxidation of essential thiol groups by affinity for these whereas this is not the case with stannic ions (7, 8, 9; 16).

It seems conceivable that the reduced metabolic activity is the main factor which causes plaque inhibition, probably because bacterial growth is reduced and also because of synthesis of extracellular materials. Beazley et al. (1980) reported that sucrose plaque grown in the presence of stannous ions in vivo contained less lipoteichoic acids, and these authors suggested that the changed physical properties of this plaque compared with sucrose plaque (it was granular, dry and non-adhesive) could be caused by reduced content of lipoteichoic acids (1).

It is generally assumed that the increase in plaque biomass is caused by growth and adhesion. One interpretation of the observed slightly reduced amounts of plaque during mouthrinses with stannic ions could be that these ions interact with surface structures of the cells, reduce the surface potentials and thus decrease the adsorption of cells to the enamel (6,10).

It seems possible that the reported instability in biological effects of aqueous solutions of stannous fluoride can be explained in terms of oxidation taking place in such solutions, decreasing the concentration of available stannous ions and increasing the amounts of inactive stannic ions.

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