Effect of Maternal Use of Chewing Gums Containing Xylitol, Chlorhexidine or Fluoride on Mutans Streptococci Colonization in the Mothers' Infant Children

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Purpose: The aim was to evaluate the effect of maternal use of chewing gums containing xylitol, chlorhexidine/xylitol or fluoride on the prevalence of mutans streptococci (MS) in the mothers' 18-month-old offsprings.

Materials and Methods: After screening 416 women with newborn babies, 173 mothers with high counts of salivary MS were randomly assigned into three experimental chewing gum groups containing A) xylitol, B) chlorhexidine/xylitol and C) sodium fluoride. Mothers with low or medium MS counts formed a reference group D without any intervention. The participants in the experimental groups were instructed to chew one gum for 5 minutes, three times a day. The chewing was initiated when the child was 6 months old and terminated one year later. The outcome measure was MS colonization in mothers' 18-month-old infants. Bacterial sampling and cultivation was carried out with the Strip mutans technique.

Results: The MS prevalence was 10%, 16%, and 28% in groups A, B, and C respectively. In the reference group D, 10% of the infants harbored MS. The difference between group C and groups A and B was statistically significant ($p<0.05$). The colonization levels in groups A and B were similar to those obtained in children of mothers with low MS counts (group D).

Conclusion: Maternal consumption of xylitol- and chlorhexidine/xylitol-containing chewing gums significantly reduced the mother-child transmission of salivary mutans streptococci.

Key words: chlorhexidine, fluoride, infants, mutans streptococci (MS), xylitol

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Dental caries is an infectious disease in which the early transmission of MS from mothers to their children is thought to play a significant role. Therefore, a primary preventive concept to suppress maternal MS levels in order to reduce or delay the colonization in the mothers' children has emerged. This has been achieved by treating the mothers with antibacterial agents such as fluoride (Dasanayake et al, 1993), chlorhexidine (Köhler et al, 1984; Köhler and Andreen, 1994), or combinations thereof (Tenovuo et al, 1992; Brambilla et al, 1998). Although proven effective in most cases, these professional methods are costly and resource demanding and have not been widely implemented. A new and self-administered regimen based on the sugar substitute xylitol has, however, recently been suggested (Söderling et al, 2000, 2001; Isokangas et al, 2000). In those studies, maternal consumption

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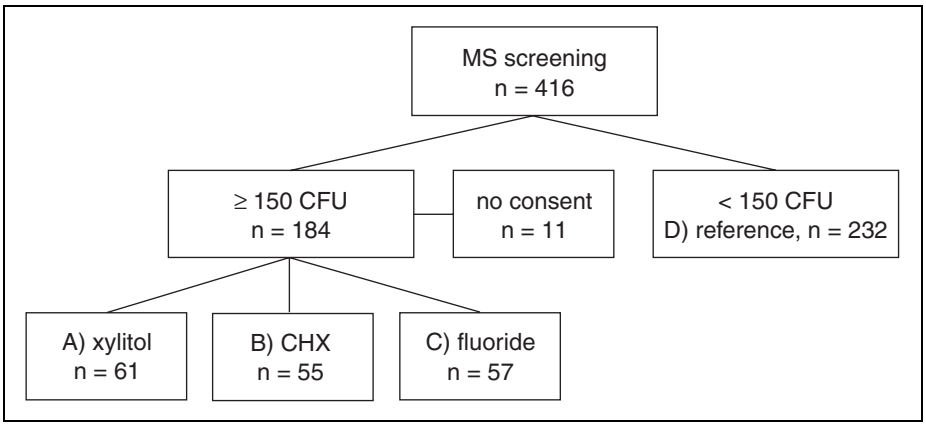

Fig 1 Study design and flow chart.

of xylitol-containing chewing gums reduced MS acquisition and dental caries development in children up to 6 years old when compared to mothers who received professional applications of either a chlorhexidine or a fluoride varnish. This was explained by the fact that habitual xylitol consumption appear to select for MS-strains with impaired adhesive properties to enamel, but it has also been discussed whether or not this was a result of the chewing itself (Imfeld, 1999; Alanen, 2001; Machiulskiene et al, 2001). It was therefore highly interesting to perform a randomized clinical trial with comparable chewing regimens in parallel experimental groups.

The aim of the present study was to evaluate the effect of maternal use of chewing gums containing xylitol, chlorhexidine/xylitol or fluoride on the prevalence of MS in the mothers' 18-month-old offsprings. The null hypothesis was that no difference in MS colonization would occur in the different experimental groups.

MATERIAL AND METHODS

Material and study design

A screening for the presence of salivary mutans streptococci was conducted in 416 healthy women with newborn infants (213 girls and 203 boys) in the community of Varberg, a mid-sized city in southwest Sweden. The mean age of the mothers was 30.1 years with a range between 17-44 years. The screening procedure was carried out by a midwife in connection with the regular well-being evaluation, 3 months after the delivery. The levels of salivary MS in the mothers were estimated using the Strip mutans chair-side test (Dentocult-SM, Orion Diagnostica, Helsinki, Finland) according to a standard procedure (Jensen and Bratthall, 1989). On the basis of the maternal MS counts, three experimental groups and one control group were formed (as shown in Fig 1). The mothers with high counts of salivary MS (≥150 colony forming units, CFU) were randomly assigned into three experimental groups and instructed to consume 3 pieces of chewing gums daily, containing xylitol, chlorhexidine/xylitol or fluoride as described below. The reference group D consisted of mothers with low or medium counts of salivary MS (<150 CFU) and no chewing gums were used. The maternal chewing was initiated when the children were 6 months old and was terminated one year later, when the child was 18 months old. Prior to the randomization, all participants were given verbal and written information and a consent form was signed. The ethics committee at Gothenburg University approved the study design.

Chewing gums

The active ingredients and sweeteners of the various chewing gums are presented in Table 1. The xylitol gum used by group A was a commercial product with each piece of gum containing 650 mg of xylitol (Xylifresh, Leaf, Finland). The chlorhexidine/xylitol gum (group B) was provided by Fertin Pharma A/S (Vejle, Denmark) and contained 5 mg chlorhexidine and 533 mg xylitol, whereas each gum of group C had 0.55 mg sodium fluoride and 289 mg xylitol

Table 1 Active ingredients and sweeteners of chewing gums used by the experimental groups

	group A xylitol gum	group B CHX/xylitol gum	group C fluoride gum
xylitol	650 mg	532.5 mg	288.5 mg
chlorhexidine	–	5.0 mg	–
sorbitol	–	141.9 mg	188.8 mg
sodium fluoride	–	–	0.55 mg
total weight/gum	1050 mg	1120.1 mg	870 mg

(Fluorette, Fertin Pharma A/S). It should be noted that the gums in groups B and C were sweetened by a combination of xylitol and sorbitol. All participants were instructed to chew one gum each day for 5 minutes in the morning, at noon and in the evening. A supply of chewing gums was provided to cover a period of three months, after which a check of the compliance was made before new chewing gums were delivered.

Dropouts

From the screening results, 184 mothers exhibited high counts of salivary mutans streptococci. Eleven of those did not want to proceed with any chewing gum and were withdrawn before randomization. The remaining 173 mother-child pairs were randomly assigned to the experimental groups according to Figure 1. During the course of the study, a total of 21 participants aborted their chewing regimen, 4 in group A, 11 in group B and 6 in group C. The major reasons were taste and gastric problems, fatigue and pain in the jaws and relocation to other communities. The final 18-month evaluation was therefore carried out in 57, 44 and 51 mother-child pairs in group A, B and C respectively. However, all dropouts agreed to show up with their babies for the 18-month evaluation.

Bacterial sampling and cultivation

The bacterial sampling of the infants was carried out at the age of 18 months, within three weeks after the mother's last chewing. A modified sampling method was used as previously described (Twetman and Grindefjord, 1999) and the levels of oral MS were estimated with the Strip mutans chair-side test. After cultivation at 37°C for 48 h, the bacteria were identified by morphology and enumerated as colony forming units (CFU) in a stereomicroscope on a predetermined area with aid of a squared lattice (Twetman and Frostner, 1991). For the mothers, the following scores were used: 0-50 CFU - low counts; 51-149 CFU - medium counts; ≥150 CFU - high counts. For the 18-month-old infants, the strips were categorized in two scores, "growth" or "no growth".

Statistical method

Data on MS prevalence in the different groups were subjected to chi-square tests.

RESULTS

The result of the screening procedure showed that 44.2% of the mothers had high levels (≥150 CFU) of salivary mutans streptococci and 49.1% exhibited low or medium counts. In 6.7%, the slides were negative. In the total 18-month-old infant group (n = 416), MS growth was detected in 13.7% and there was no statistical difference between the sexes. The number of individuals that harbored MS in the different experimental groups is presented in Table 2. No difference was disclosed between the xylitol and chlorhexidine/xylitol groups but both

Table 2 Maternal MS levels in saliva at baseline and prevalence of colonization in mothers' 18-month-old offsprings in the different experimental and reference groups

	group **A** xylitol n=57	group **B** CHX n=44	group **C** fluoride n=51	group **D** reference n=232
Baseline maternal MS levels in saliva CFU, mean ±SD	188 ±21	185 ±25	191 ±18	28 ±32
Infant MS colonization				
Number yes/no	6/51	7/37	14/37	23/209
percent	10.5	15.9	27.5	9.9

showed a significantly ($p<0.05$) lower MS colonization when compared with the sodium fluoride group. In fact, the values in groups A and B were similar to those obtained among the infants in the non-intervention reference group D. The highest MS prevalence (28.6%) was found among the children of the highly MS-colonized dropout mothers (n=21). According to the medical records, no differences in socio-economic characteristics were disclosed between any of the experimental or dropout groups.

DISCUSSION

This study was initiated to evaluate the possible influence of maternal xylitol consumption on the mother-child transmission of caries associated MS. A previous study has suggested that this could be the case although chewing gum controls were lacking (Söderling et al, 2000). The results of the present study are however clearly supportive to that report since the null hypothesis was rejected and xylitol chewing gums reduced MS colonization in infants of mothers with high MS counts when compared with fluoride-containing chewing gums. The finding concerning CHX/xylitol-containing gums was novel although similar results have been previously reported with CHX-gel (Köhler et al, 1984; Tenovuo et al, 1994). Interestingly, the effects of xylitol and chlorhexidine did not seem to be additive. The negative finding from the fluoride intervention was in agreement with the results of Dasanayake et al (1993). Although chewing and saliva stimulation certainly may affect MS colonization, it is probable to assume that the demonstrated differences were due to the active ingredients in the different gums. The same MS prevalence was found in the fluoride chewing gum group and in the dropout group that aborted the program during the first three months, which indicates a limited role of chewing. Slightly more participants dropped out from group B compared with groups A and B, because the taste was subjectively perceived as less attractive. There was a slight difference in weight and sweetness of the chewing gums, which to some extent may have influenced the results. Apart from compliance, the higher weight and sweeter taste of the group A and B gums might have accounted for an enhanced saliva production. It should however be noted that the MS prevalence found in group C was almost identical to that of a non-intervention group of 18-month-old infants within the same community and sampled with the same microbial technique (Thorild et al, 2002).

The present results can enlighten the debate on the effective daily dosage of xylitol. In this study, the daily intake in experimental groups A and B was approximately 1.5 g xylitol, which is considerable less compared to what has been used in previous studies (Tanzer, 1995; Söderling et al, 2000; Alanen, 2001). On the other hand, in group C, in which the daily intake of xylitol was less than 1 g, no effect was seen. It thus seems reasonable to assume that a daily maternal consumption of at

least 1-1.5 g xylitol was needed to affect the MS colonization in the offspring.

Our findings indicate that both xylitol and chlorhexidine may affect MS colonization in infants, but the mechanism of action may be diverse. Habitual consumption of xylitol can initiate an ecological shift in the plaque in favor for xylitol-resistant strains, which are claimed to have diminished adhesive properties (Trahan, 1995). Thus, the offspring may not be exposed to fewer MS per se, but the bacteria are less likely to attach to teeth in a permanent way. On the other hand, chlorhexidine in low concentration exerts a bacteriostatic effect (Emilson, 1994) and presumably suppressed the counts in the mothers' saliva. Consequently, their children could have been subjected to a reduced MS exposure. Unfortunately, we have no bacterial data available from the mothers during the period of chewing gum consumption that could elucidate these assumptions.

In this study, we report an intervention that can reduce the MS colonization in infants but it should be noted that this does not necessarily mean that less caries appear later in life. Previous studies have, however, demonstrated such a relationship (Köhler and Andreen, 1994; Isokangas et al, 2000) and a longitudinal evaluation of the present study groups with microbial and clinical data is underway. Furthermore, an economical analysis will be carried out in order to evaluate not only the effect but also the efficiency of the present intervention. However, the program is not intended on a community-wide basis and requires a risk selection procedure. The concept of including non-dental staff in the screening and selection of targeted mothers was practical and moneysaving since no extra dental visits were required for the implementation of the program.

In conclusion, the present study supports the assumption that maternal consumption of xylitol- and chlorhexidine-containing chewing gums can significantly reduce the mother-child transmission of salivary mutans streptococci.

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