Efficacy of chlorhexidine varnish applications in the prevention of early childhood caries

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ABSTRACT. Aim A prospective clinical study was conducted to evaluate the influence of 3-monthly applications of the chlorhexidine-containing varnish Cervitec® on the colonisation of a child’s oral cavity by mutans streptococci (MS) and on caries prevalence. Methods 200 children aged 11.7 ± 0.7 months were examined. Children’s caries risk was assessed on the basis of their MS scores in saliva. Out of the 48 children in whom a high caries risk (≥10⁵ CFU/ml) was expected, 23 were treated with Cervitec® at 3-month intervals (CHX group). The remaining 25 children of the high-risk group received no treatment and served as controls (group C). All parents received detailed information on the prevention of early childhood caries. 172 children had completed the study after one year. Results During the course of the study the percentage of children with visible plaque on their maxillary incisors increased from 17.8% to 40.1% and the percentage of children given sweetened drinks in nursing bottles for the night rose from 16.3% to 18.0%. At the closure of the study 26.2% of the two-year-olds had salivary scores of MS ≥10⁵ CFU/ml of saliva. The mean d₁-₄mft value increased from 0.05 ±0.4 to 0.8 ±2.9 and the mean d₁-₄mfs value rose from 0.08 ± 0.8 to 1.8 ± 5.9. No significant differences were demonstrable between the two-year-olds in groups CHX and C for colonisation of the oral cavity by MS or for d₁-₄mft values. In contrast the d₁-₄mfs values were significant lower in the CHX group as in the group C. Conclusion Poor feeding habits and deficits in oral hygiene cannot be compensated by the application of Cervitec®.

KEYWORDS: Early childhood caries, Chlorhexidine, Mutans streptococci.

Introduction

Early childhood caries (ECC) is essentially an avoidable disease, as it has dietary and behavioural causes, such as the use of nursing bottles with sweetened drinks, that lead to the destruction of primary teeth [Wetzel, 1989]. First mutans streptococci (MS: S. mutans, S. sobrinus) are usually transferred to the child from maternal saliva [Berkowitz et al., 1975, 1981; Berkowitz and Jones, 1985; Caufield et al., 1993; Li and Caufield, 1995; Kneist et al., 2004]. Subsequently sweetened drinks in nursing bottles, in particular, foster the propagation of such micro-organisms, so that primary teeth are exposed to the acid metabolic products of MS for a prolonged period of time [Kneist et al., 2004]. Mutans streptococci are demonstrable already in saliva before [Florio et al., 2004; Ramos-Gomez et al., 2002; Wan et al., 2003] or shortly after the eruption of first primary teeth [Mattos-Graner et al., 1998; Tanner et al., 2002].

Many parents hardly respond if recommended to change their habit of using nursing bottles with sweetened drinks [Ismail, 1998]. Evaluating chlorhexidine (CHX), an effective antimicrobial substance, against MS [van der Hoeven and Schaeken, 1995; Twetman, 2004] as a complementary measure for the prevention of nursing bottle caries, has been suggested.

As the direct application of germ-reducing substances in the oral cavities of infants is covered by the results of only a few studies [Lopez et al., 2002; Twetman, 2004; Wan et al., 2003], it was intended to investigate the effect of CHX applications on MS colonisation of the oral cavities of young children and on caries prevalence in these children in a prospective clinical study.
Materials and Methods

The approval of the ethics committee of the Medical Faculty of Dresden Technical University had been obtained for the conduct of this study.

Study population. A population of 200 children aged 11.7 ±0.7 months participated in the baseline examination (E1). The children were patients from five country or city paediatric offices visiting paediatricians between September 2001 and March 2002. Exclusion criteria comprised:

- oral antibiotic therapy within the four weeks preceding the examination;
- serious general systemic disease;
- a birth weight of less than 2500 g.

Only 172 children participated in the examination after 1 year (E3), mostly due to failure of keeping appointments or change of residence. The 28 children who had dropped out and those who completed the study did not differ significantly for socio-demographic and clinical findings.

The 6-monthly examinations (E1, E2, E3) evaluated dentition status, initial white-spot carious lesions and cavitated lesions (d₃₉₉₉, d₃₉₉₉₉) [Marthaler, 1966], as well as visible plaque on the maxillary incisors. All examinations were carried out by one examiner. An inter- and intra-examiner calibration was carried out (Cohen’s kappa 0.9 and 0.8) at the Biological Laboratory in Jena.

A questionnaire was used to obtain data on general medical history, feeding and oral hygiene habits, as well as on the use of fluorides. Salivary MS counts were determined at all 3 examinations in both mother and child using CRTbacteria® (Ivoclar Vivadent AG, Schaan, Liechtenstein). In children the saliva samples were taken with the help of plastic spatulas that were turned several times on an area of 2/3 of the upper surface of the tongue [Kneist, 2001; Andree et al., 2004]. Paraffin-stimulated saliva was collected in mothers. The microbiological assays of all saliva samples from mothers and children followed the manufacturer’s instructions. The causes of ECC were explained extensively to all mothers and detailed instructions on their prevention were provided in a verbal and written form.

Children were allocated to caries risk groups according to the level of the mutans streptococci scores found in their saliva samples [Kneist et al., 2004]. A low risk (LR) of caries was assumed with scores 0 and 1 (≤10⁵ CFU/ml) (LR group; n = 125), while scores 2 and 3 (≥10⁵ CFU/ml) were associated with a high risk of caries (HR group, n = 47). After consent of their mothers had been obtained, 23 children of the high-risk group had a small amount of Cervitec® (Ivoclar Vivadent AG, Schaan, Liechtenstein) applied to their teeth at 3-month intervals (CHX group) after teeth had been cleaned with a small brush and dried with a swab. The remaining 24 children from the high-risk group had no treatment (group C). Cervitec® contains 1% w/w chlorhexidine diacetate and 1% w/w thymol as active antimicrobial agents.

The data were analysed using SPSS 9.0 for Windows (Chi-square test, Fisher’s exact test, regression analysis). A significance level of p <0.05 was applied to all calculations.

Results

Alterations in health-related behaviour. The percentage of children who had their teeth cleaned at least once daily increased from 56.5% to 94.2% during the observation period. While at baseline 16.3% of the children were given sweetened drinks in nursing bottles during the night, this portion had risen to 18.0% after one year.

Fluoride tablets were given to 91.0% of one-year-olds and also to 70.3% of the two-year-old children. Fluoridated domestic salt was used to prepare the food of 59.7% of the one-year-olds and of 96.4% of the two-year-old infants. Fluoride toothpaste (500 ppm F) was used for 31.5% of one-year-old children and 94.2% of the two-year-olds. The combination of fluoride tablets plus fluoridated salt plus fluoride children’s toothpaste was reported as used by 65.1% of the two-year-olds. The fluoride concentration in local drinking water was ≤0.2 ppm. A comparison for feeding habits and routines of oral hygiene as well as the use of fluorides revealed no significant differences between the two-year-olds in groups CHX and C.

Microbiological examinations. The CHX applications were well tolerated by the young children investigated. MS were found in 62.5% of the one-year-olds and in 75.6% of two-year-old children. Among the children who had positive MS counts at baseline there were 3 in whom no primary teeth had yet erupted. Final examination (E3) showed that 26.2% of the children had salivary MS scores of 2 and 3 (≥10⁵ CFU/ml). More than 70% of the mothers had stable salivary MS scores of 2 and 3 (≥10⁵ CFU/ml). At the end of the study the children of groups CHX and C showed no significant differences for the prevalence of MS in saliva (Fig. 1). At E1 and E3 significant correlations (p < 0.01) between MS scores of the mothers and their children were found (Fig. 2).

Clinical examination. Within the observation period the percentage of children with visible plaque on
upper incisors increased from 17.8% to 40.1%. At baseline (E1) 197 of 200 children (98.5%) had naturally healthy teeth, while at the final examination (E3) this could be claimed for only 143 out of the 172 children (83.1%).

Among the two-year-old participants white-spot lesions (d1,2t) were diagnosed in 16 children and cavitated carious lesions in 13 (d3,4t).

At the end of the study the children of the low-risk group had the lowest d1-4mft and d1-4mfs values (0.5 ±1.8; 1.0 ±3.6). Group C showed both the highest d1-4mft values (1.9 ±3.9) and the highest d1-4mfs values (4.5 ± 8.5). The d1-4mft value of the CHX-group was 1.2 ± 1.7, their d1-4mfs value was 3.2 ± 4.4. While no significant difference was demonstrable between groups CHX and C for their d1-4mft values (Fig. 3), such difference existed in terms of d1-4mfs values (Fig. 4).

**Caries predictors.** Significant correlation was determined between the development of dentine caries within the second year of a child’s life and the intake of sugary drinks during the night, absence of regular cleaning of teeth and salivary MS scores 0 and 1 (<10⁵ CFU/ml) in one-year-olds and high salivary MS scores...
2 and 3 (≥10^5 CFU/ml) in the mothers (Table 1).

Regression analysis demonstrated that one-year-olds with a positive MS test (salivary score ≥1) carried an 8.6 times higher risk of developing dentine caries (d3,4t) versus children who were MS negative (p = 0.017; CI 95%: 1.4–16.9). Children continuing to have sweetened drinks in nursing bottles beyond the age of 1 year carried a 5.9 times higher risk of dentine caries (p = 0.003; CI 95%: 1.5–17.4).

**Discussion**

This study employed two different strategies for the prevention of ECC in that all mothers of the one-year-old children were regularly educated on the development and prevention, as well as the consequences, of this disease. In addition all erupted primary teeth of a small group of children were treated with chlorhexidine at 3-month intervals. These frequent interventions were directed at an enhanced influence on health-related behaviour and also at an immediate influence on the MS colonisation of a child’s oral cavity and hence on the potential caries prevalence of a child.

The allocation of children to groups CHX and C depended on the mothers’ voluntary participation in the 3-month appointments for CHX applications. The mothers of the children in the CHX group would thus receive five advisory impulses while the mothers of the other children would have only two or three. It could be expected that the more frequently given advice would have a stronger influence on mothers of the CHX group than on the other participants as regards their behavioural patterns for caries prevention. However, differences between groups CHX and C were not significant in this respect; it follows, therefore, that the 3-month recall visits provided no benefit as against the six-month appointments.

The prevalence of ECC observed in this study was 16.8% (9.3% of white-spot lesions, 7.5% of cavitated lesions) in the two-year-old children. Similar rates of prevalence were found in other regional studies in Germany [Plotzitza et al., 2005]. The major cause of such wide distribution of ECC lies in the misuse of sweetened drinks in nursing bottles offered to children with the intent to pacify them. The evaluation of crucial behavioural parameters showed that poor feeding habits could hardly be influenced. But at the end of the study 94.2% of the mothers involved claimed to clean the teeth of their children. On the other hand the proportion of children with visible plaque on their maxillary incisors had increased within the follow-up period. This would suggest that mothers could be motivated quite successfully to care for dental hygiene in their children but depended on even better instructions on the practical issues of cleaning the teeth of an infant. The data on fluoride application suggests that there is an excess for the 2-year-olds. This would also indicate there is strong need for more precise instructions to the parents.

The effectiveness of similar educational programs for the parents of young children has met with quite diverging opinions in the literature [Strippel, 2004]. The social stratum of parents is always considered an essential influencing factor [Plotzitza et al., 2005]. Authors also agree that it is very difficult to wean small children from their bottles [Ismail, 1998]. With the present cultural practice of routinely offering the nursing bottle prevailing in Germany, all appeals to change this habit unfortunately are bound to meet with little response for as long as this practice is accepted.

MS usually were transferred to the child by saliva of

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**Table 1** - Association of caries prevalence (d3,4mft) in two-year-old children with feeding practices, oral hygiene habits and salivary scores of mutans streptococci of children and their mothers at baseline.
mothers [Li and Caufield, 1995]. MS need tooth surfaces for colonisation but their transient presence can be estimated in the mouth of small children before the eruption of first primary teeth [Wan et al., 2001; Ramos-Gomez et al., 2002; Florio et al., 2004]. After tooth eruption, the number of infected children increases with the further eruption of different tooth groups and with the age of children [Catalanotto et al., 1975; Edwardsson and Mejare, 1978; Alaluusua and Renkonen, 1983; Roeters et al., 1995].

At baseline 62.5% of the 12-month-old children were infected by MS and 75.6% of two-year-old children. In concordance to Twetman et al. [2000], Kneist [2001] and Andree et al. [2004] the high prevalence of salivary MS of the children is not the result of higher percentage of sucrose in CRT® bacteria [Laurisch, 1997], on which MS can grow more luxuriously. Differences in counts of mitis salivarius bacitracin agar (MSB) [Gold et al., 1973] and MSB broth of Dentocult® SM versus MSB agar of the dip slides of the CRT® bacteria are not significantly different.

No influence of CHX applications on the MS scores of children was demonstrable in our own investigations. As the mean interval between the application of the CHX varnish and the next microbiological evaluation was three months, it is conceivable, however, that reductions in microbial counts were only short-lived and thus could not be registered. In terms of time, the growth suppression in MS depends on the number of organisms persisting after CHX application and on growth condition in the oral cavity [van der Hoeven and Schaeken, 1995]. The number of children with very frequent sugar intake, who were evenly distributed in groups CHX and C, makes a long-term reduction in MS scores appear quite improbable.

In the 10-month-old children, with low salivary MS scores at baseline, Wan et al. [2003] were able to observe a further reduction of MS scores for three months after these infants had their teeth brushed with a 0.2% CHX gel once weekly for 12 weeks. However, the significant difference between the children receiving the CHX gel and those receiving a placebo gel was no longer demonstrable after 15 months. What the authors were able to show was, in fact, the superior influence of oral hygiene and the feeding habits of children on the colonisation of a child’s oral cavity by MS.

Likewise the influence of CHX applications on caries prevalence in two-year-olds fell short of expectations. At the end of the observation period the children in the low-risk group (LR) had the lowest dmft values and the children in group C had the highest dmft values. The difference between groups CHX and C was not significant, whereas a significant difference did exist between the dmfs values of groups CHX and C. Still, carious tooth surfaces were significantly less in the children of the LR group than in the CHX group. That means that the application of Cervitec® at least was able to influence the progression tendency of carious lesions. MS were in concordance to Borutta et al. [2002] successful parameters for risk assessment in small children. These risk factors should be identified as early as possible. The progression of early caries was also successfully delayed as compared with the placebo-treated controls when 12 to 19 months old children with four erupted incisors had antimicrobial treatment [Lopez et al., 2002], although these children also were given nursing bottles with cariogenic contents to lull them to sleep and had MS-colonised plaque.

**Conclusion**

The mere application of a chlorhexidine-containing varnish does not prevent early childhood caries, but may influence the progression tendency of carious lesions. Not to pacify children with nursing bottles containing sweetened drinks but to make them drink from a cup as early as possible continues to be the crucial measure of preventing early childhood caries. In addition parents need to be shown under real-life conditions how to clean the teeth of their small children, so that an early formation of health-promoting habits is supported. These recommendations need to be spread both by physicians and dentists informing the individual patient about oral health.

**Acknowledgements**

These investigations were supported by Ivoclar Vivadent AG (Schaan, Liechtenstein) who provided CRT® bacteria and the chlorhexidine-containing varnish Cervitec®.

**References**


