Influence of Dental Restorative Materials on Salivary *Streptococcus mutans* and Lactobacilli in the Primary Dentition

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Purpose: When restoring deciduous teeth with extensive lesions, preformed stainless steel crowns are increasingly used in addition to resin-based materials. The aim of the present clinical study was to examine the influence of composites and stainless steel crowns on the cariogenic bacteria *S. mutans* and Lactobacilli by means of a commercially available salivary test (CRT® bacteria) in 100 children.

Materials and Methods: For 50 children (30 boys, 20 girls, mean age 5.7 ± 2.4 years) only composites have been used as a restorative material (an average of 9 fillings per child, total number: n=450), which had been in situ for an average of 15.9 months at the time of the examination. In another group of 50 children (33 boys, 17 girls, mean age 5.9 ± 2.5 years), stainless steel crowns and composites have been used for restorations (an average of 3.5 stainless steel crowns per child, total number: n=174, an average of 7 composite fillings per child, total number n=348), which had been in place for a mean period of 17.2 months.

Results: The salivary examination of the children with composite restorations showed a high proportion of patients (64%, n=32) with high numbers ($\geq 10^5$) of *S. mutans* and Lactobacilli (54%, n=27). Only 22% (n=11) of the children with additional stainless steel crown restorations were found to have high numbers ($\geq 10^5$) of *S. mutans* and Lactobacilli (34%, n=17).

Conclusion: This study shows a potential positive inhibitory effect of stainless steel crown restorations as compared to composite fillings with respect to the oral bacterial colonization.

Key words: restorations of the primary dentition, composite, preformed steel crowns, salivary tests

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The development of dental caries is essentially a result of unhealthy dietary habits with a high consumption of sugar, insufficient oral hygiene measures and an inadequate use of professional dental care. While intense prophylaxis measures and educational campaigns about the increase of the market share of sugar-free foods have led to a decrease in the prevalence of dental caries in industrialized countries, an increase in caries could be observed in many third-world countries because of increased sugar consumption (Einwag, 1992).

The formation of plaque, the subsequent unrestricted bacterial growth and metabolic activities, as well as the development of secondary caries and the occurrence of recurrent caries play a key role in the carious destruction of the first dentition.

The absorption of salivary proteins on the enamel as well as on the dental restorative materials and other prosthetic and orthodontic materials in the oral cavity play an important role in the development of the salivary pellicle as a basis for bacte-

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rial attachment mechanisms (Lamkin, 1996; Vacca-Smith, 2000). The interaction between the salivary environment and surface structures is influenced by various factors such as surface property, pellicle stratum and individual microbial and host responses (Edgerton, 1993).

When evaluating potential caries-etiologic parameters, the increased presence of certain strains of bacteria in the saliva is considered as a caries-pathogenic risk factor. *S. mutans* and Lactobacilli are undisputedly considered important caries-etiologic bacterial strains, as verified in numerous scientific studies (Fitzgerald, 1968; Kohler et al, 1995; O'Sullivan and Thibodeau, 1996). These bacterial strains produce especially high concentrations of various organic acids, which lead to a demineralization process of the dental enamel. The detection of both cariogenic bacterial strains with commercially available salivary tests is considered a sensible and established method for the early detection and assessment of the caries risk as part of the primary prevention. A significant correlation could be established between high numbers of *S. mutans* in plaque and saliva (Kneist et al, 1998). The use of salivary tests for the potential determination of an increased caries risk is sensible, especially for decisions about various restorative materials, because of certain differences in the adhesive properties of the oral microorganisms in dental materials (Göcke et al, 2002). The presently available resin-based composite filling materials as well as the metal restorative materials exhibit a clear tendency towards plaque accumulation and therefore lead to an influence of the total bacterial quantity in the saliva (Satou, 1988).

In line with the recommendations made by the German Federal Department of Health (Bundesgesundheitsamt – BGA) in 1992 to not use amalgam for children less than 6 years old if possible, this restorative material with pronounced bactericidal properties continues to lose ground in pediatric dentistry. Resin-based composite filling materials are used increasingly, and they show a higher accumulation of plaque than metal filling materials (Svanberg et al, 1990). In addition to the surface properties of the individual dental surfaces or the restorative materials, the availability of inorganically charged elements is discussed for the formation of the biofilm (Carlén et al, 2001). Preformed children's crowns made of an alloy of chrome, nickel and steel, which are used increasingly for the restoration of severely damaged molars of the primary dentition, are easy to use, have a high strength and a long durability because the smooth surface structure results in low supragingival plaque accumulation (Chao, 1992). The present clinical comparative study was aimed at determining the potential influence of composites and steel crowns in the primary dentition on the cariogenic bacteria *S. mutans* and Lactobacilli in the saliva.

MATERIALS AND METHODS

In the present study, a total of 100 children (63 boys, 37 girls, mean age 5.8 ± 2.5 years) were interviewed anamnestically and received a dental examination. After clarification of the potential restorative treatments and of the children's willingness to cooperate, and after consideration of the mixed dentition and the subsequent development of the dentition, a restoration therapy, with or without intubation anesthesia (ITA) was selected. Children with severe general illnesses, mental or physical disabilities, metabolic diseases or severe general diseases including long-term medication were excluded from the study. The selected children had similarly poor oral hygiene (API value > 50%) and a correspondingly high accurrence of dental caries (dmf-t > 3) in the beginning of the study.

All children were treated by a dentist with experience in pediatric dentistry (using situationally local anesthesia or procedures were performed under ITA, respectively). The respective restorative materials were always selected taking into account the degree of destruction of a tooth, the willingness of the children to cooperate, and the wishes of the parents.

In a group of 50 children (30 boys and 20 girls, mean age: 5.7 ± 2.4 years) the restorative procedures were performed exclusively with resin-based composite material (Group I, Figs 1, 2). For these children a restorative treatment with composite materials was chosen because of the extent and the localization of the cavities, but also because it was possible to avoid contamination with moisture absolutely or relatively (rubber dam or cotton rolls). Tetric Ceram (Vivadent, Schaan, Liechtenstein) and Charisma (Heraeus-Kulzer, Hanau, Germany) were used as restorative materials for about the same number of cavities, they were placed and finished according to the manufacturers' instructions.

In a second group of 50 children (group II; 33 boys and 17 girls, mean age: 5.9 ± 2.5 years) a suc-

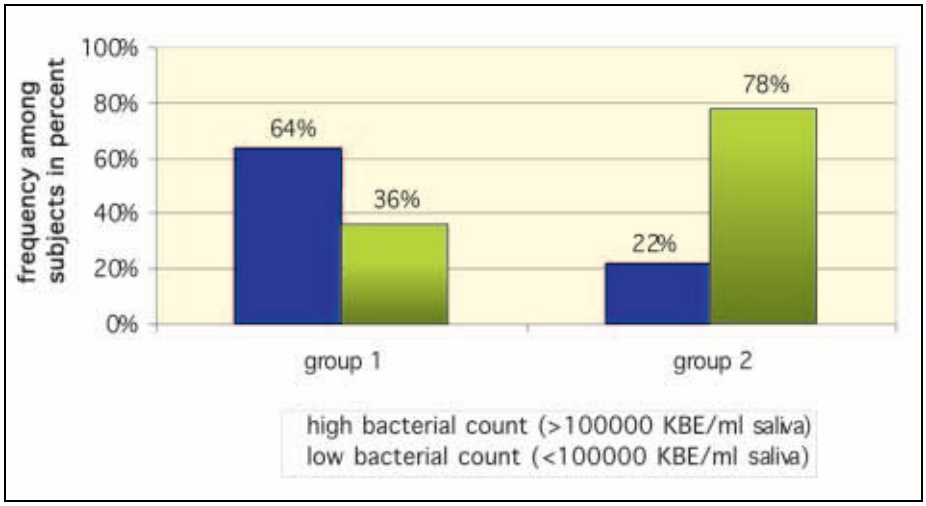

Fig 1 Comparative analysis of the salivary counts of streptococcus mutans with the CRT® bacteria test; group I (n=50) – treatment with composite resin materials and group II (n=50) – treatment with preformed steel crown.

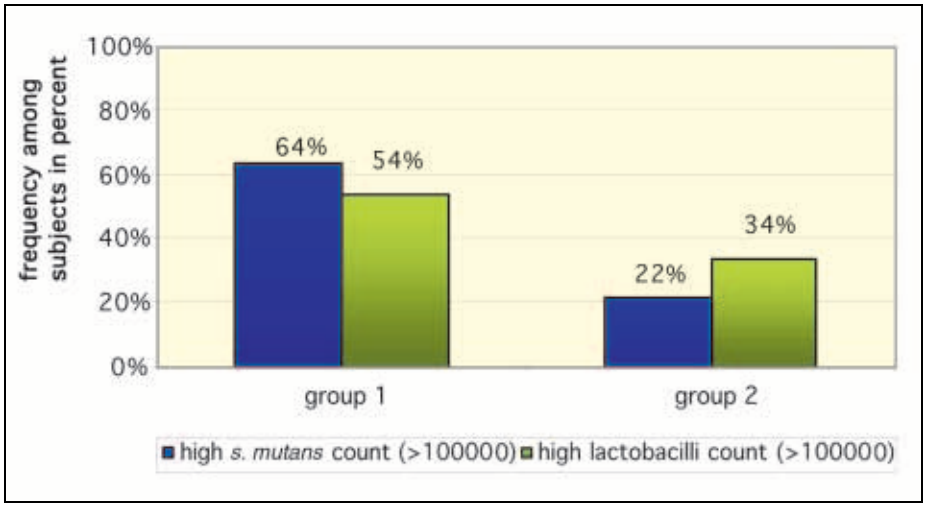

Fig 2 Comparative analysis of the saliva for streptococcus mutans and lactobacilli; Children in group I (n=50) – treatment with composite resin materials and group II (n=50) – treatment with preformed steel crowns.

cessful restoration of the dentition could only be performed by means of steel crowns (ION-NI-CRO Crowns, 3M ESPE, Seefeld Germany) and resin-based composite materials (Tetric Ceram, Charisma). This kind of treatment was chosen after evaluation of the dental assessments and x-rays and a discussion with the parents.

The salivary parameters for all children were determined a minimum of 3 months after the last restoration. The commercially available Chairside-Salivary-Test CRT® bacterium (Ivoclar/Vivadent) was used for the microbiologic determination of the saliva for the entire sample of 100 children. A thorough cleaning with a water spray was performed in all children before the dental assessment, and 10 min later the salivary samples for the determination of *S. mutans* and *Lactobacillus* were collected. The children chewed on a piece of paraffin wax in order to stimulate the salivary flow, and saliva was collected in a plastic beaker. The saliva samples from all children were taken at the same time (9.00 am to 12.00 pm) in order to avoid fluctuation of the results because of the time of day. No food was to be eaten for a minimum of one hour prior to the test. The agar-covered test system was then carefully moistened with saliva, it was replaced in its transparent plastic container and kept for 48 h at 37ºC in an incubator (Cultura©, Ivoclar/Vivadent). The results of the tests were read by comparing images according to the instructions of the manufacturer, and the bacterial counts found in both groups were compared.

This double test detects the cariogenic bacteria *S. mutans* and *Lactobacillus* in only one procedure. For semi-quantitative determination of the number of bacteria, the bacterial colony growth on the agar

was compared with the included charts. The result was expressed as either = 10^5 colony forming units (CFU) of *S. mutans* or Lactobacilli per ml saliva or as = 10^5 colony forming units.

Salivary samples from a group of children without fillings, serving as controls, have not been collected. Because of the high costs of the tests and the unnecessary generation of clinical waste, determination of the bacterial counts in this group had no meaningful indication.

The statistical analysis of the data was made with SAS (SAS Institute Inc., Cary, NC, USA. Release 6.12). For the descriptive illustration of the results in the groups, absolute and percentage frequencies were used for categorical variables, and median, mean, minimum and maximum values were used for quantitative and ordinal variables. The correlations between categorical variables were analyzed with contingency tables and Fishers Test (bilateral). The group comparison of quantitative and ordinal variables was made with the Wilcoxon test for unlinked samples. All statistical tests were used for a descriptive data analysis.

RESULTS

The 100 children selected for the present study showed an average plaque value (API) of 74.2 ± 20.5% at the initial exam. A mean caries value (dmf-t; DMF-T) of 8.9 ± 3.7 was determined. A total of 50 children, which on the basis of the existing defects could be treated exclusively with resin-based composite materials, showed at baseline signs of gingivitis in 34% of the cases, and a mean caries value (dmf-t, DMF-T) of 8.3 (group I). Additionally, 50 children received a restorative therapy with steel crowns and resin-based composite filling materials (group II; dmf-t, DMF-T: 9, gingivitis: 40%). No significant differences were found in the oral hygiene (API values of the composite group: 73.6%; API values of the steel crown group: 74.8%) and caries frequency (dmf-t value, DMF-T value).

The restoration therapy was performed using ITA for 79 of the total of 100 children because of their insufficient compliance and because of the large number of restorations needed. 71 of those children (89.9%) were treated once under ITA, whereas a second ITA was necessary for 8 children (10.1%). The group of 50 children who were treated exclusively with resin-based composite materials (38 children under ITA, 2 children with two ITAs) had an average of 9 composite restorations (total: n = 348) with an average in-situ time of 15.8 months. The 50 children who received treatment with composites and steel crowns (41 children treated with one ITA, 6 children treated with two ITAs) had an average of 3.5 steel crowns with an average in-situ time of 17.2 months. Within this group, a total of 174 preformed steel crowns were placed, of which 66% (n=115) were located in the mandible and 34% (n=59) in the maxilla.

At the time of the post-treatment check-up exam, which was performed 3 months after completion of the restorations, and upon verification of the oral hygiene compliance, 20 of the children (40%) in the composite restoration group had new carious lesions. 18 (36%) of the children in the group with steel crowns and composite restorations had new carious lesions; no significant difference could be noted between the two groups. The occurrence of new carious defects within the short follow-up period of 3 months can be explained by the fact that during treatment under ITA exclusively visually and radiographically detectable, large carious defects were being restored; early lesions remained essentially unconsidered.

Significant differences in the bacterial counts for *S. mutans* and Lactobacilli were observed between the two comparison groups. A significantly higher amount of *S. mutans* was found in group I (restoration with composite fillings exclusively) compared with group II (restorations with composites and steel crowns) ($p<0.05$). 64% of the patients in group I (n=32) had an elevated bacterial count of *S. mutans* (= 10^5) in their saliva (Fig 1). In group II, 22% of the patients (n=11) had an elevated bacterial count (= 10^5) of *S. mutans*. In this group, 78% of the patients (n=39) exhibited low bacterial counts (< 10^5) of *S. mutans*, compared with only 36% of the patients (n=18) who were treated exclusively with composite restorations (Figs 1, 2). Equally significant differences could be observed when comparing the bacterial counts of Lactobacilli in the saliva of the two groups of children with dental restorations ($p<0.05$). 54% (n=27) of the children with exclusive composite restorations (group I) had an elevated bacterial count of = 10^5 colony forming units (CFU) per milliliter of saliva. Only 34% (n=17) of those children who had a combination of steel crowns and composite restorations had an elevated bacterial count of Lactobacilli in the saliva samples (Fig 3).

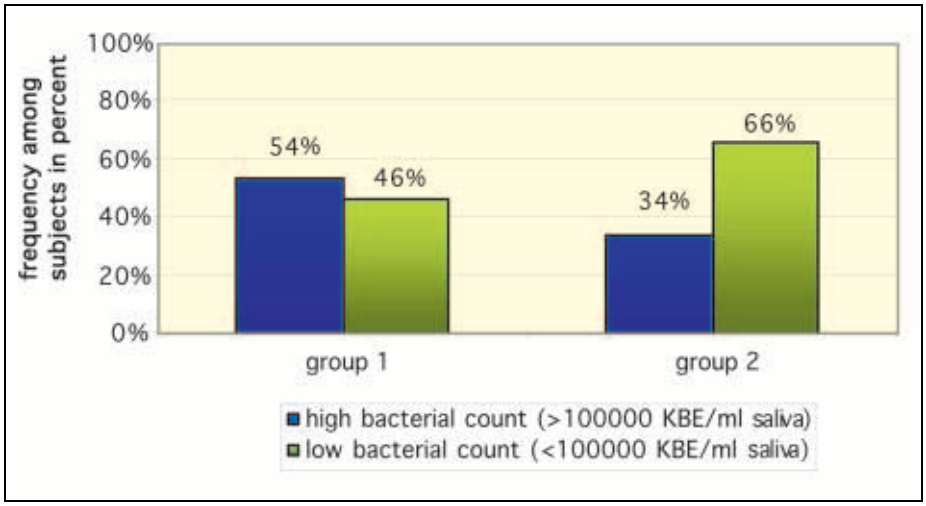

Fig 3 Comparative analysis of the lactobacilli found in the children's saliva with the CRT® bacteria test; group I (n=50) – treatment with composite resin materials and group II (n=50) – treatment with preformed steel crowns.

DISCUSSION

Because of saliva production, the cavity of the mouth, its teeth and dental restorative materials, as well as the neighboring soft tissues are constantly coated with glycoprotein. The formation of pellicle films as the basis for future plaque formation depends on the surface, which they coat, as well as on the neighboring physical and chemical interactions. When evaluating potential caries-etiologic parameters, certain strains of bacteria found in the saliva are considered to be caries-pathogenic risk factors. *S. mutans* and Lactobacilli are undisputedly considered important bacterial strains in caries etiology (Alaluusa, 1989; Kohler, 1994; O'Sullivan, 1996; Laurisch, 1999).

Petti et al (2001) showed, that the treatment of caries lesions might cause a lowering of *S. mutans* concentration to the same levels as those shown by carious free persons. The present study, in which the saliva of children was examined after treatment with dental restorations, was aimed at determining the potential influence of different restorative materials on quantities of *S. mutans* and Lactobacilli.

The comparison of the saliva samples taken from children with different restorative materials showed the positive influence of preformed steel crowns on the reduced total count of the cariogenic bacteria *S. mutans* and Lactobacilli and therefore on the caries risk. When evaluating the amount of plaque, the individual influence of tongue movement and other mechanical factors such as cheek contact and chewing movement is critical. However, this fact was not considered in the present study because this applies equally to all children.

One important factor in the altered bacterial counts could be explained by the different bactericide material properties of steel crowns and resin-based composites and the resulting influence on the accumulation of plaque. The significantly lower accumulation of plaque at steel crowns compared with the neighboring natural teeth and the entire cavity of the mouth has been described many times in the literature (Durr et al, 1982; Einwag, 1983; Chao, 1992). Mundorff et al (1990) verified a correlation between the numbers of *S. mutans* in plaque and in the saliva. The decreased accumulation of plaque at steel crowns could be correlated with the smooth and polished surface (Peterson et al, 1978). The decreased Lactobacilli count can possibly be linked to the fact that Lactobacilli are predominantly found in retention niches, which are reduced because of the smooth surface of steel crowns. Furthermore, Einwag (1983) describes improved oral hygiene among children with steel crowns because they brush their teeth more often in order to keep their crowns shiny. In contrast, the highest accumulation of plaque and the highest count of *S. mutans* were found on composite fillings compared to other filling materials (Skjorland, 1976; Satou, 1988). A previous study (Willershausen et al, 1999) showed a bacterial surface degradation and an increased count of *S. mutans* on various resin-based composite materials. This effect can probably be traced back to the surface roughness of the restorative material, which facilitates the accumulation of bacteria at a value of 0.2 µm or more (Bollen et al, 1997). Therefore,

changes in the mouth biotope of patients who where predominantly treated with resin-based composite materials cannot be excluded (Svanberg et al, 1990). Although the material properties of resin-based materials have improved continuously in recent years, no major advances could be observed with respect to the anti-plaque effects and the improvement of the biologic properties. However, preformed steel crowns can be regarded as a sensible choice for restorations of teeth of the primary dentition because of their high durability and their low plaque accumulation. Additionally, the risk of secondary caries can be reduced considerably when a technically correct treatment is performed.

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