Influence of dental plaque pH on caries status and salivary microflora in children following comprehensive dental care under general anesthesia

Yng-Tzer J. Lin*, Yai-Tin Lin

Pediatric Dentistry, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Taiwan

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Abstract  Background/purpose: There is no report in examining dental plaque pH after dental care under general anesthesia. This study investigated the effects of comprehensive dental rehabilitation under general anesthesia on the oral environment of children with severe early childhood caries (S-ECC) and the influence of dental plaque pH on caries recurrence and salivary microflora.

Materials and methods: Thirty-seven children (mean age, 51.08 ± 9.68 months) with S-ECC who underwent comprehensive dental treatment under general anesthesia were selected. Caries index, plaque pH, and Streptococcus mutans (SM) and Lactobacillus (LB) counts were evaluated during the initial examination and 6-month and 12-month follow-ups.

Results: The plaque pH was significantly greater at the 6-month follow-up examination than at the initial examination (P = 0.006) and at the 12-month follow-up (P = 0.002), but there was no significant difference in plaque pH between the initial examination and the 12-month follow-up (P = 0.942). SM and LB counts at the sixth and twelfth months were significantly lower than the initial counts (P < 0.001). Plaque pH did not show strong correlations with caries index and SM and LB counts at the three time-points (P > 0.05).

Conclusion: The comprehensive dental rehabilitation under general anesthesia for children with S-ECC caused a temporary significant increase in the plaque pH at the sixth month and a significant reduction in the salivary microflora during the 12-month follow-up. Plaque pH
Introduction

Many studies have shown that comprehensive dental treatment under general anesthesia for severe early childhood caries (S-ECC) may provide an immediate enhancement in the patients’ oral health and quality of life. However, these patients showed a high caries recurrence rate, ranging from 53% to 80%, regardless of aggressive dental rehabilitation and preventive efforts. It has been suggested that dental caries is a multifactorial disease in which the cumulative and combined interactions of different risk factors should be evaluated. Thus, our aim was to elucidate the possible factors associated with caries recurrence after dental rehabilitation under general anesthesia.

Our previous study found that 79.7% of children with S-ECC who were treated under general anesthesia presented with new caries during a 12-month follow-up examination. The count of salivary Streptococcus mutans (SM) was associated with new caries development when compared free-sites with caries-recurrent subjects after a 12-month follow-up examination. With respect to plaque pH and its association with caries, a low plaque pH with high caries activity was first observed by Stephan. Some studies later reported that a decreasing plaque pH profile was associated with an increasing caries status. However, two studies found no difference in plaque pH response on caries-active and caries-inactive subjects and tooth surfaces, which is not concurrent with the mechanism of caries formation.

Information about the relationship between plaque pH and salivary microflora is also limited. Two previous studies found that plaque acidogenicity was more pronounced and acidic in the ‘high-SM group’ than in the ‘low-SM group’ at all test periods, while a significant difference was only found at the final pH period. Another study indicated that an increasing caries status is characterized by increasing plaque levels of highly acid-tolerant, acidogenic bacteria such as SM. However, the findings from the above studies were difficult to reach substantial significant difference and involved less than 10 subjects.

Little is known about the changes in plaque acidogenicity and salivary microflora after comprehensive dental rehabilitation under general anesthesia and the mechanism by which these changes affect the caries status of a population with S-ECC. Therefore, the aims of the present study were to investigate the effects of comprehensive dental rehabilitation under general anesthesia on the oral environment of children with S-ECC and to determine the potential risk factors, including plaque pH and salivary microflora, associated with caries recurrence.

Materials and methods

The study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (IRB no: 101-3606C). A total of 79 children (40 boys and 39 girls) with early childhood caries, requiring full mouth dental rehabilitation under general anesthesia were recruited from the Children’s Dental Clinic of Kaohsiung Chang Gung Memorial Hospital. The parents of the children were invited to participate in the study and were instructed to sign consent forms.

Study design

Prior to administration of general anesthesia, S. mutans (SM) and Lactobacillus (LB) counts were measured using Dentocult-SM and Dentocult-LB test kits (Orion Diagnostica, Espoo, Finland), respectively. Participants were instructed not to swallow their saliva for 1 min after chewing paraffin pellets and transfer into Dentocult-SM tube. Participants were then instructed to spit out all saliva continuously into a plastic cup for the next 4 min and transfer into a Dentocult-LB tube. The Dentocult-SM and Dentocult-LB tubes were stored in an incubator at 37 °C for two and four days, respectively. The SM and LB salivary counts were obtained by comparing the colony density on the test strips against a standard chart provided by the manufacturer. The bacterial amounts were graded as I (≤10^4 CFU/mL saliva), II (10^7–10^8 CFU/mL saliva), III (10^8–10^9 CFU/mL saliva), or IV (≥10^9 CFU/mL saliva).

Immediately after the participant was anesthetized, dental examinations were conducted by two pediatric dentists (Lin JYT and Lin YT) using on-site dental chairs, mirrors, and explorers under focused flashlights. Caries status was assessed using decayed, extracted, and filled teeth (deft) index according to the World Health Organization diagnostic criteria (WHO, 1997). Plaque pH measurements were performed using a Beetrede NMPH-3 0.1 mm-diameter palladium touch microelectrode connected to a portable Orion Perphect Model 370 unit. To create a reference salt bridge, subjects immersed a finger in 3 M KCl solution containing a DRIREF-5 4.7 mm-diameter porous glass reference electrode (World Precision Instruments Inc., Connecticut, USA) connected to the pH meter. Electrodes were sterilized in 2.5% w/v glutaraldehyde and re-calibrated with standard buffers of pH 4.0 and 7.0 between each reading. Plaque pH was measured on the interproximal gingival crevice of six assigned sites (AB, DE, IJ, KL, NO, and ST). Each site was recorded as the average of three repeated measurements. The plaque pH for each subject was then recorded as an average of the six assigned sites. After recording the above measurements, all teeth...
were isolated with a rubber dam and treated with a restoration, a pulpotomy with a crown, a pulpectomy with a crown, or an extraction according to the severity of the carious lesions.

The SM and LB counts, caries status, and plaque pH measurements were repeated in the clinic six and twelve months after the initial examination. Physical restraint with the parent’s permission was sometimes necessary when the child was uncooperative during the examinations. Subjects with incomplete examinations due to uncooperative behavior were excluded and the total number of subjects dropped from 79 to 37.

Statistical analysis

Two examiners (Lin JYT and Lin YT) participated in a pilot study that involved 10 cases for deft. The inter-examiner reliability tested using a kappa score was 0.83. Comparisons of plaque pH and bacterial counts at different time intervals were determined using a paired-sample t-test and Wilcoxon signed-rank test. Pearson’s correlation was used to test the possible correlations between plaque pH, caries status, and bacterial counts at different time intervals. Data were analyzed using statistical software (Statistical Package for Social Sciences 19 for Windows, Chicago, IL, USA). A P value < 0.05 was considered to be significant.

Results

The final group of 37 children included in this study comprised of 16 boys and 21 girls, aged 33–69 months (mean age, 51.08 ± 9.68 months). The mean plaque pH values at the initial examination, 6-month follow-up and 12-month follow-up were 6.744 ± 0.252, 6.887 ± 0.178, and 6.740 ± 0.227, respectively. The mean deft was 11.950 ± 3.374 at the initial examination, then decreased to 0.950 ± 1.201 at the 6-month follow-up and increased to 1.950 ± 1.794 at the 12-month follow-up. The plaque pH was significantly greater at the 6-month follow-up examination than at the initial examination (P < 0.001) and at the 12-month follow-up (P = 0.002), but there was no significant difference in plaque pH between the initial examination and the 12-month follow-up (P = 0.942) (Table 1). SM and LB counts at 6-month and 12-month follow-up examinations were significantly reduced compared to their initial counts (P < 0.001). However, there were no significant differences between 6-month and 12-month in SM (P = 0.636) and LB counts (P = 1.000) (Table 2). Plaque pH did not demonstrate significant correlations with deft, SM count, and LB count at the initial, 6-month, and 12-month follow-up examinations. Only LB count at the 6-month follow-up examination showed a significant correlation with plaque pH (P = 0.03) (Table 3).

Discussion

A full mouth comprehensive dental rehabilitation under general anesthesia is an effective method for treating multiple destructive dental decay of children with ECC.21 Dental treatment under general anesthesia allows high-risk subjects to recover to a caries-free status and allows us to determine the factors that influence recurrence of caries. Regarding the mechanism of caries development, it has been suggested that endogenous bacteria (largely SM) in the biofilm produce weak organic acids as a by-product of metabolism of fermentable carbohydrates.22 This acid causes local pH values to fall below a critical value resulting in demineralization of tooth tissues.23 If the demineralization of the tooth persists, then it will eventually lead to cavitation.23,24 However, information about

| Table 1 | Comparisons of plaque pH at initial, 6-month and 12-month examinations. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| N               | Mean ± SD       | Test statistics | P               |
| Initial         | 37              | 6.744 ± 0.252   | 0.006*          |
| 6 M             | 37              | 6.887 ± 0.178   | 0.942           |
| 12 M            | 37              | 6.740 ± 0.227   | 6 M vs 12 M 0.002* |

*Significant difference (P < 0.01). SD = standard deviation; M = month.

| Table 2 | Comparisons of each SM and LB salivary counts at initial, 6-month and 12-month examinations. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Bacterial amount| I               | II              | III             | IV              |
| Initial         | 0               | 5               | 10              | 22              |
| 6 M             | 7               | 12              | 7               | 11              |
| 12 M            | 11              | 6               | 9               | 11              |

| Test statistics (P) | SM | LB |
|--------------------|----|----|
| Initial vs 6 M     | 0.000* | 0.000* |
| Initial vs 12 M    | 0.000* | 0.000* |
| 6 M vs 12 M        | 0.636 | 1.000 |

*Significant difference (P < 0.001).
SM = Streptococcus mutans; LB = Lactobacillus; M = month.

| Table 3 | Pearson's correlations (P value) of plaque pH with deft, SM count, and LB count at initial, 6-month, and 12-month examinations. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Initial plaque pH| 6 M plaque pH | 12 M plaque pH |
| Initial deft    | 0.139           | 0.171           | 0.233           |
| SM              | 0.281           | 0.217           | 0.030*          |
| LB              | 0.413           | 0.543           | 0.489           |

*Significant difference (P < 0.05). Deft = decayed, extracted, and filled teeth; SM = Streptococcus mutans; LB = Lactobacillus; M = month.
the role of plaque pH and salivary microflora in caries development, especially in children with ECC, is limited.

The present study examined patients with S-ECC and found that plaque pH increased significantly six months after the initial examination, but returned to its original status 12 months after the initial examination. Regarding the salivary microflora, SM and LB counts at the 6-month and 12-month examinations were significantly lower compared to those at the initial examination. After comprehensive dental care under general anesthesia, the children’s oral environment had significantly improved during the first six months. However, it gradually returned to its original condition, and it might be due to the parents’ willingness to improve their children’s oral hygiene immediately after such impact of dental care under general anesthesia.

While comparing plaque pH with caries status at each time interval, no strong correlations were found, suggesting that less acidic plaque pH in the oral environment did not result in decrease in the caries status of the subjects (Table 3). Our study suggests that there is no correlation between the plaque pH response and the caries status of high-risk children with S-ECC. As previously described, dental caries is a multifactorial disease in which the cumulative and combined interactions of different risk factors should be evaluated. Saliva, for example, plays a role in the modification of plaque pH, especially in caries-resistant people. Although remineralization of the tooth surface occurs as plaque pH increases, cavitation may occur, especially in children with ECC, because of other risk factors such as cariogenic bacteria, inadequate salivary flow, poor oral hygiene, inappropriate methods of feeding infants, and poverty.

Regarding the relationship between plaque pH and salivary microflora, plaque pH did not show strong correlations with salivary microflora (SM and LB), with the exception of the LB count at the 6-month follow-up examination (Table 3). The results of this study were inconsistent with those of a study by Aranibar Quiroz et al., which showed that plaque acidogenicity was more pronounced and acidic for the 'high-SM group' compared to the 'low-SM group'. However, their study involved a small sample size and a real significant difference was difficult to reach at each test periods. Nevertheless, a decreased LB count at the 6-month follow-up examination had a temporary strong correlation with an increased plaque pH, which should be examined in future studies.

In conclusion, the effects of comprehensive dental rehabilitation under general anesthesia for children with S-ECC included a temporary significant increase in plaque pH at the 6-month follow-up examination and a significant reduction in the salivary microflora (SM and LB) during the 12-month follow-up examination. Plaque pH did not demonstrate any strong correlations with caries status and salivary microflora in children with S-ECC.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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