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ORIGINAL RESEARCH

Effect of the Presence of Dental Plaque on Oral Sugar Clearance and Salivary pH: An *in vivo* Study

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ABSTRACT

Background: Fermentable carbohydrates and microorganisms in the plaque play a significant role in the pathogenesis of dental caries. Oral clearance of sugars and salivary pH is affected by the presence of plaque.

Aims and objectives: This study was conducted to study the effect of the presence of plaque on the salivary clearance of sucrose and on salivary pH.

Materials and methods: The study design was of a randomized controlled parallel group clinical trial and included two groups: The control group and plaque group, as follows: Control group—subjects without plaque and plaque group—subjects with plaque. Salivary sucrose determination was done by using the anthrone technique. A digital pH meter estimated the salivary pH. The Student's t test and Mann-Whitney test was employed to compare the intergroup differences. Pearson's correlation coefficient was used for analysis.

Results: The salivary sucrose clearance time was increased by presence of plaque.

Conclusion: The presence of plaque led to increased salivary sucrose concentrations and increased the salivary sucrose clearance time.

Clinical significance: The dental caries is the dynamic relationship among the dental plaque microbiota, dietary carbohydrates, saliva and cariogenic potential of the dental plaque. Caries occur preferentially in the dentition sites characterized by high exposure to carbohydrate and diminished salivary effect.

Keywords: Plaque pH, Sucrose clearance, Dental plaque, Dental caries, Salivary pH.

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INTRODUCTION

It is well-established that organic acids in dental plaque are related to the development of dental caries.[1] This acid production is initiated when many carbohydrates are introduced into the oral cavity. However, sucrose is the most important carbohydrate contributing to dental caries and is sometimes termed 'the arch criminal'.[2] The pathogenesis of caries involves dissolution of fermentable carbohydrates, such as sucrose, in saliva. The sucrose is subsequently transported into the dental plaque by diffusion. The rate of transport is proportional to the concentration gradient of the sucrose between saliva and plaque fluid.[3] This implies that the rate of salivary clearance is one of the determining factors for the availability of fermentable substrates to the bacteria in the plaque. As a consequence, importance has been attributed to salivary sugar clearance in the development of dental.[4-6] The time period during which sugar is present in saliva is also important, and after a sugar-containing drink or meal is consumed, the salivary sugar concentration decreases with time, a process generally referred to as oral sugar clearance.[4,7,8] Oral clearance of sugars has been studied in the past but the effects of the presence of dental plaque on oral sugar clearance and salivary pH has not been investigated in adolescents.

OBJECTIVES

1. To study the effect of the presence of plaque on the salivary clearance of sucrose.
2. To study the effect of the presence of plaque on salivary pH.

MATERIALS AND METHODS

The study design was of a randomized controlled parallel group clinical trial. Sixty adolescents aged 12 years were included as the study participants. Sample size was calculated based on pilot study. Ethical clearance was obtained from the institutional review board. Informed consent was obtained from the parents of the participants

after explaining the study to them in the local language. Plaque scores were measured using the plaque index by Silness and Loe.[9] The subjects were divided into two groups: The control group (plaque score ≤1) and plaque group (plaque score >1). On the day of saliva collection, participating children were instructed not to eat or drink anything for at least 1 hour before the collection of saliva sample. To control the circadian variations, samples were collected in the morning. Children were asked to rinse their mouth with water thoroughly 10 minutes before collection of saliva to avoid the contamination of food debris. For collection of resting saliva, the children were instructed to let saliva collect in the floor of the mouth without swallowing it for atleast 1 minute, and then to expectorate into the sterile graduated measuring cylinder with the help of a sterile funnel. This procedure was continued for a period of 5 minutes. This saliva was used to measure the baseline salivary flow rate, sucrose concentration and salivary pH. The children were then given 25% 10 ml of sucrose solution and were asked to keep it in their mouth for 1 minute and then swallow. Unstimulated saliva samples were collected for 60 minutes at different time intervals (0, 2, 4, 6, 8, 10, 20, 30 and 60 minutes). The saliva samples were analyzed for salivary sucrose concentrations and salivary pH. Salivary sucrose determination was done using the anthrone technique (Halhoul and Kleinberg, 1972).[10] Salivary pH was estimated by using a digital pH meter.

STATISTICAL ANALYSIS

The independent sample t-test and Mann-Whitney U test was employed to compare the intergroup differences. Pearson's correlation coefficient was used for correlation of the plaque scores with salivary sucrose clearance and salivary pH.

RESULTS

A total of 60 (33 males and 27 females) children aged 12-year-old were included in the study.

Mean salivary flow rates for the control group and the plaque group at the baseline were found to be 0.66 ± 0.13 ml/minute and 0.47 ± 0.11 ml/minute respectively and the difference was found to be statistically significant ($p < 0.01$) (Table 1).

Mean salivary sucrose clearance time, that is, time at which the salivary sucrose concentration reaches the baseline level, were found to be 8.22 ± 2.1 minutes for the control group and 10.95 ± 3.4 minutes for the plaque group and the intergroup differences revealed that sucrose was cleared from the oral cavity significantly faster in the control group when compared to the plaque group ($p < 0.01$) (Table 2).

Table 3 shows the comparison of the mean salivary pH at different time intervals for both the groups. Salivary pH at the baseline for the control group and the plaque group were found to be 6.88 ± 0.12 and 6.45 ± 0.12 respectively. This difference was found to be significant ($p < 0.000$).

Immediately after sucrose exposure, the mean salivary pH in the control group and the plaque group were found to be 5.6 ± 0.11 and 5.19 ± 0.12 respectively, and this difference was statistically significant ($p < 0.01$). The salivary pH values at various time intervals were found to be significantly lower in the plaque group when compared to the control group.

The plaque score of the subjects was positively correlated with the sugar clearance time ($r = +0.927$, $p < 0.05$), whereas the baseline salivary pH was negatively correlated to the plaque score of the study subjects ($r = –0.87$, $p < 0.05$).

Table 1: Mean salivary flow rates for the control group and the plaque group at the baseline

Group	*Mean ± standard deviation (ml/min)*	*p-value**
Plaque group	0.47 ± 0.11	<0.05
Control group	0.66 ± 0.13	

*Independent sample t-test

Table 2: Mean salivary sucrose clearance time in the groups

Group	*Mean ± standard deviation (in min)*	*p-value**
Plaque group	10.95 ± 3.4	<0.01
Control group	8.22 ± 2.1	

*Mann-Whitney U test

Table 3: Comparison of the mean salivary pH at different time intervals for both the groups

Time intervals	*Plaque group*	*Control group*	*Significance**
Baseline	6.45 ± 0.12	6.88 ± 0.12	$p < 0.05$
0 min	5.19 ± 0.12	5.6 ± 0.11	$p < 0.01$
2 mins	5.42 ± 0.71	5.81 ± 0.21	$p < 0.01$
4 mins	5.64 ± 0.37	6.01 ± 0.18	$p < 0.05$
6 mins	5.79 ± 0.65	6.24 ± 0.31	$p < 0.01$
8 mins	6.06 ± 0.29	6.47 ± 0.54	$p < 0.05$
10 mins	6.13 ± 0.2	6.62 ± 0.21	$p < 0.01$
20 mins	6.21 ± 0.1	6.65 ± 0.1	$p < 0.01$
30 mins	6.33 ± 0.82	6.81 ± 0.33	$p < 0.05$
60 mins	6.41 ± 0.43	6.83 ± 0.21	$p < 0.01$

*Mann-Whitney U test

DISCUSSION

Dental caries is basically due to the action of bacteria in dental plaque which convert certain dietary carbohydrates to acids which cause decalcification of the teeth. In this process, the concentration of sugar in the saliva will influence its availability to the dental plaque by controlling the diffusion gradient between saliva and plaque.[11] The rate of oral sugar clearance is dependent on several factors which have received little investigation.

In our study, it was seen that sucrose was cleared from the oral cavity significantly faster in the control group, when compared to the plaque group as well as the amount of sugar in the saliva was significantly higher in the plaque group at various time intervals. This finding was in agreement with a study conducted by Kumar et al.[12] Plaque may act as a reservoir of the sucrose solution, which in turn may be released in the saliva at a later stage. This may be due the structure of plaque.[13]

Salivary pH at the baseline and immediately after sucrose exposure for the control group was significantly higher than the plaque group. The salivary pH values at various time intervals were found to be significantly lower in the plaque group when compared to the control group. This difference may be attributed the plaque present in the oral cavity. It has been well established that the cariogenic bacteria in the plaque metabolize the sugar present in the food to form acid which lowers the salivary pH and hence leads to dental caries.[14]

CONCLUSION

The presence of plaque increased the salivary sucrose clearance time and led to decreased salivary pH at various time intervals, including at the baseline. The plaque score of the subjects was positively correlated with the sugar clearance time, whereas the baseline salivary pH was negatively correlated to the plaque score of the study subjects.

CLINICAL SIGNIFICANCE

Dental caries is a complex interplay of various factors like plaque, saliva, diet, tooth morphology. A clear understanding of all these factors and their inter-relationships is absolutely essential for the assessment of caries risk and prevention.

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