Original Article

A Comparative Evaluation of Sucrose, Sorbitol and Sugar Free Chewing Gum on Plaque pH in Children after Sucrose Challenge

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ABSTRACT

Introduction: Dental caries is a multifactorial disease. Ingestion of various dietary sugars plays dominant role in the caries etiology. Clinical evidence shows that the use of sugar-free chewing gum does not lead to caries, presumably because the sugar substitutes used do not lead to the production of metabolic acids in plaque at a rate sufficient to cause a fall in pH and to attack the teeth. The present study aimed to evaluate and compare the effect of sucrose and sorbitol chewing gums and sugar free chewing gum on acidogenicity of plaque after sucrose challenge.

Methodology: 78 volunteers (48 boys and 30 girls) aged 6 -14 years were randomly divided into 3 groups comprising 26 children in each group. In the present controlled trial, three types of chewing gums: sucrose based, sorbitol based and natural gum were used. One type of chewing gum was used in each group. Plaque pH was recorded before and after sucrose challenge at different time intervals. Same experiments were repeated along with other chewing gums.

Results: The sucrose challenge decrease the plaque pH, however all the types of chewing gums used in the present study prevented the decrease in plaque pH caused by sucrose challenge. The effects were statistically significant ($p<0.01$). The prevention of the fall in plaque pH was observed to be less by sucrose gum as compared to the effect caused by sweetener gum and natural gum.

Conclusion: It is concluded that the use of sugar free chewing gums prevents the fall in plaque pH caused by sucrose challenge. The patient should be instructed to use a sugar free gum within 5 minutes of eating and to continue chewing for at least 20 minutes.

INTRODUCTION

Dental plaque is composed primarily of micro-organisms. A variety of bacteria have been found in dental plaque, which are associated with dental diseases such as caries, gingivitis and periodontitis. The importance of acid production by bacteria from fermentable carbohydrate leading to the complex of dental decay was recognized as early as in 1890 by Miller.[1] The bacterial metabolism produces an increase in the concentration of organic acids, primarily lactic acid. This increase in the hydrogen ion concentration or drop in the plaque pH results in demineralization of tooth. This has given encouragement to the concept that preventive measures should be directed towards removal of the plaque. Therefore, there should be an agent which when brought in contact with the tooth structure alters the nature of the plaque.

In view of human likeness for sweet, it is difficult to control/ restrict the sucrose consumption in order to reduce the incidence of dental caries. To address the problem various artificial sugar substitutes (Sorbitol, Xylitol) and high intensity sweeteners (Aspartame, Saccharine and Acesulphame –K) have been included in many food products, chewing gums and soft drinks. The products are claimed to be safe in respect to cariogencity by manufactures. Study conducted by Imfeld[2] indicates that these sugar alternatives undoubtedly can be effective in prevention of dental caries. He found efficacy of these in caries prevention depends upon their use as table top sweeteners in soft drinks and as bulk sugar substitutes in

"safe for teeth" confectionary. In these forms, they actually do replace the fermentable sugars, thereby passively reducing the total cariogenic load of the individual's diet.

Chewing sucrose-free gums is a convenient way to increase salivary flow.[3] Increased salivary flow rate increases pH, promotes enamel re-mineralization and buffering capacity, and reduces caries.[4] Studies have reported that chewing sugar free gums after meals may be beneficial to oral health but do not support the use of the sugar containing gum as a caries preventive measure.[5] The present study was conducted to study the plaque pH reversal phenomenon and analyze the protective effect of chewing sucrose containing gum, sucrose alternative gum (containing sorbitol, mannitol, and aspartame) and natural gum. In the present study, the effect of all three types of gums was compared for the acidogenicity of plaque after sucrose challenge.

METHODS

The study was conducted in the Department of Pediatric and Preventive Dentistry, Faculty of Dental Sciences, King George Medical University, Lucknow and was approved by the institutional ethical committee. Seventy eight children (48 boys and 30 girls) of age group 6 to 14 years were enrolled in the present study. All the subjects had at least 20 natural teeth, with moderate to marked deposition of plaque. Those who had caries experience were restored and were free of active caries at the time of experiment. Written consent from the parents/guardian was obtained. The subjects were instructed not to clean their teeth for 48 hours, prior to the experiment however during this period they were allowed to maintain the normal dietary habits. All the subjects were randomly (computer generated randomization) divided into three groups- A, B and C with 26 individuals in the each group. In each group one type of test chewing gum was used. The chewing gums were of same colour and appearance to avoid any bias and were coded as A, B and C to make the study double blind.

Test chewing gums: Following three types of chewing gums were used in this study.

1. **Sucrose Gum** containing sucrose, glucose, corn syrup. The weight of sweeteners was 2 gm and weight of each piece of chewing gum was 3.2 gm.
2. **Sugar alternative gum** containing sorbitol, mannitol and aspartame. The weight of sweeteners was 1.7 gm and weight of each piece of chewing gum was 2.7 gm.
3. **Natural gum** – No sweeteners were used. The weight of each piece of gum was 2 gm.

The acidogenic challenges were done by 15 ml, 10% (w/v) sucrose solution which was used as a mouth rinse for 2 minutes. Double ionized distilled water was used to dissolve plaque. Normal saline was used to rinse the oral cavity.

The subjects were asked not to clean their teeth for 48 hours and refrained from taking food or drink for 2 hours before appointment on the day of the experiment. Samples of plaques were removed with the help of a loop indigenously made from buccal and lingual aspects of all upper and lower teeth except the lower anterior teeth (to avoid salivary contamination). The sample was dissolved in 2 ml double deionized distilled water and pH of the suspension was measured by the pH meter.

The pH of the plaque was measured with the help of single electrode electronic pH meter by plaque sampling method. After determining the resting pH, the subjects were asked to rinse with 15 ml of 10% w/v sucrose solution for 2 minutes. The plaque pH measurements were conducted 5, 10, 20, 30 minutes after the sucrose challenge. The same subjects were then allowed to rinse the oral cavity thoroughly with the normal saline and the baseline pH was measured as above. Then the subject was instructed to rinse with 10% w/v sucrose solution for determination of plaque pH in the first minute.

After determination of plaque pH, the subjects started to chew the test chewing gum and continued till the end of experimental period (30 minutes). The subjects had been instructed to chew on one side of the mouth and samples for pH determination were taken from the other side of the mouth. The plaque pH measurements were carried out for 30 minutes as scheduled. All the readings were taken 10 seconds after the insertion of electrode in the test tube containing plaque and distilled water. The changes in plaque pH after the imitation of chewing were recorded at 5, 10, 20, 30 minutes. After each testing the pH meter was checked regularly and standardized with the buffer of pH 7 and pH 9.

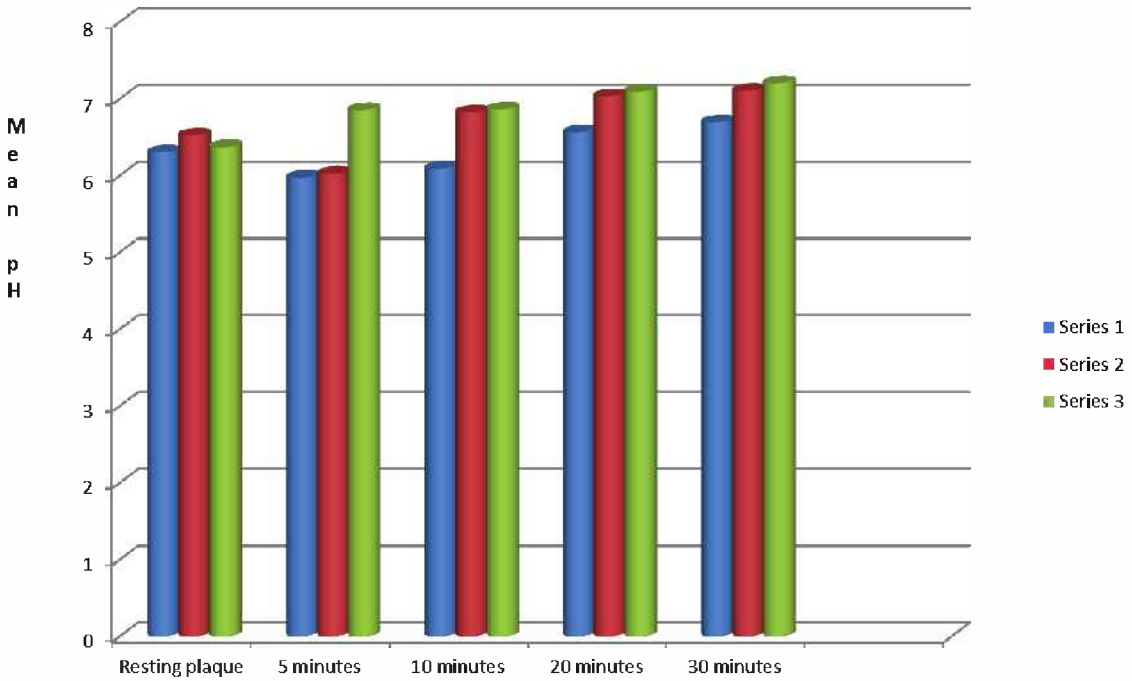

Figure 1: Comparative data of plaque pH values after having sucrose gum, sweetener gum and natural gum.
Series 1: Plaque pH after sucrose rinse with sucrose gum treatment
Series 2: Plaque pH after sucrose rinse with sweetener gum treatment
Series 3: Plaque pH after sucrose rinse with natural gum treatment

Time interval identification:

- Interval A: 2 minutes; Gap after baseline recording of pH
- Interval B: 2 minutes; Sucrose rinse
- Interval C: 30 minutes; Plaque pH was recorded at 5, 10, 20 and 30 minutes
- Interval D: Subjects were asked to rinse thoroughly with normal saline
- Interval E: 2 minutes; Gap after resting pH recording
- Interval F: 2 minutes; sucrose rinse
- Interval G: 30 minutes; plaque pH was recorded at 5, 10, 20 and 30 minutes while the patient was chewing gum

Table 1: Comparative data of plaque pH value after sucrose challenge with and without sucrose gum, sweetener gum and natural gum

Plaque pH	Resting plaque	5 Minutes	10 Minutes	20 Minutes	30 Minutes
without sucrose gum	6.58±0.07	5.99±0.01	5.76±0.03	6.02±0.01	6.18±0.05
with sucrose gum	6.30±0.04	5.97±0.03#	6.09±0.02#	6.56±0.07#	6.69±0.02#
without sweetener gum	6.52±0.01	6.02±0.05	5.99±0.09	6.05±0.08	6.25±0.09
with sweetener gum	6.52±0.01	6.02±0.05	6.82±0.09	7.03±0.09	7.10±0.07
without natural gum	6.57±0.03	6.10±0.08	6.02±0.09	6.12±0.03	6.29±0.06
with natural gum	6.37±0.01	6.85±0.09*	6.86±0.06*	7.09±0.08*	7.20±0.05*

The value of group A are significant as compared to values shown at respective time intervals at group B.
* The value of group C is significant as compared to values shown at respective time intervals at group A.

RESULTS

There was no significant difference in the baseline values of the plaque pH among the three groups and when the sucrose challenge was done, a fall in plaque pH was observed which had a similar pattern in all the three groups. In all the experiments, the sucrose rinse was followed by a typical increase in H^+ ion concentration with its maximum after 10 minutes of the sucrose challenge. However, when the sucrose challenge was done for the second time and subsequently gum was allowed to chew, a series of variables were observed, with different types of gums, at the progressive time interval.

After having sucrose containing chewing gum (Group A) initially pH falls but was less pronounced and of shorter duration than in experiments without chewing. Thus, the pH drops at 5 and 10 minutes but tends to increase after that. Sucrose containing chewing gum itself contains sugar so initially, it lowers the plaque pH but after some time, it might be dissolved out and swallowed within a few minutes of chewing and subsequent use of the same piece of gum is equivalent to the use of sugar free product. In both group B and group C, plaque pH values were raising progressively after the consumption of sweetener gum and natural gum.

The plaque pH values for all three groups, after sucrose challenge, with and without use of gum afterwards are summarized in table1. Difference of plaque pH between sucrose gum and sweetener gum and was found to be significant ($p<0.01$) at the entire time interval. However, difference of plaque pH between without sweetener gum and sweetener gum is not significant ($p>0.05$) at the entire time interval.

DISCUSSION

Oral cavity is a dynamic field and saliva plays a crucial role in maintaining the equilibrium between remineralization and demineralization of tooth structures. This equilibrium gets altered during meal time, sleep and during oral hygiene measures. A meal containing a carbohydrate item such as sucrose, glucose that can be rapidly fermented by oral microorganisms will lead to surprisingly fall in salivary pH. Moreover, if the meal is followed by another sugary item the demineralization potential of saliva will further increase. Hence, chewing of a non-sugary item will increase the salivary flow and so as will reduce the demineralizing potential of saliva by mechanical cleaning and chemical buffering.[6,7]

The present study was designed to observe the effect of natural gum and two types of chewing gums – sugar containing and sorbitol containing on acidogenicity of the plaque. Although the acidogenicity produced by the sugar and sugar free gum is known to differ, when they are chewed without the prior sucrose challenge. It can be argued that in case of sugar containing gum, the sugar might be dissolved out and swallowed within a few minutes of chewing. The subsequent use of the same piece of gum is equivalent to the use of a sugar free product. This may partly account for the apparent effect of gum chewing on the plaque pH when it is previously lowered by acidogenic snacks or meals. In addition, the effect of the relatively small contribution of sugars from the piece of gums is swamped when it follows immediately after a more intense sugar challenge.

In the present study, it was found that sucrose rinse reduces the plaque pH. This finding is in concurrence with one of the earliest studies[8] in which it was observed that when plaque on the surface of the tooth is exposed to fermentable carbohydrate the pH falls rapidly and after some time gap slowly rises back to resting values. This increase in pH is due to increased salivary flow and increase in bicarbonate ions from blood to saliva.[9] Since then numerous investigators[5,9,10,11] have found that the lowered plaque pH after carbohydrate exposure has been found to return rapidly to resting levels when paraffin or similar substance is chewed to stimulate salivary flow. Certain foods, such as cheese[12,13] has also shown to produce a rapid rise in plaque pH in vivo, hence accelerate the return of plaque pH to neutrality.

The results from the present study indicate that the drop in the plaque pH, after sucrose challenge can be rapidly reduced by chewing gum in the same manner as has been illustrated with various snacks and gum chewing in other studies.[14,15,16] In order to reduce the time period of demineralization following meal consumption, individual at high risk for dental caries should be encouraged to chew gum following meal consumption. The act of gum chewing also reduced acid challenges and enhances remineralization by salivary stimulation.[2,17,18] The present study confirms the findings of the previous studies[5,11] that plaque pH falls after exposure to fermentable carbohydrate and its return to neutrality is more effective with the use of sugar free rather than sucrose containing chewing gum. Therefore, sugar alternative gum and

natural gum are superior to sucrose in reducing the acidogenicity of plaque and the effects of the both of these are statistically significant as compared to sucrose gum.

Health professionals should be aware of long term effects of sucrose containing gums/liquids. The chewing of sucrose free chewing gums can be recommended as an aid in standard regime/protocol of oral hygiene especially in hospitalized children and in children with special needs.

CONCLUSION

Chewing of sugar free gums after the meals may be beneficial to oral health but do not support the use of sugar containing gum as caries preventive measures. If chewing gum is recommended, the patient should be instructed to use a sugar free gum within 5 minutes of eating and to continue chewing for at least 20 minutes.

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