Effect of mastication on flow and properties of saliva

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Purpose: The purpose of this study was to evaluate the effect of the mastication for meal on the flow rate and property of secreted saliva.
Materials and Methods: Forty-six subjects participated this research with informed consent. Stimulated and unstimulated saliva were collected 30 minutes before a meal. Unstimulated saliva was also collected 0, 10, 20, 30, and 60 minutes after a meal. Amount of the collected saliva was measured and flow rate was calculated. The pH and buffering capacity of saliva were evaluated using a commercially available kit.
Results: Salivary flow rate, pH and buffering capacity of stimulated saliva were higher than those of unstimulated saliva collected 30 minutes before a meal. The flow rate, pH and buffering capacity of the unstimulated saliva collected just after meal (0 minute) were statistically higher than those 30 minutes before and 20, 30, and 60 minutes after a meal.
Conclusion: It was concluded that the stimulation induced by the intake of a meal affected flow rate, pH and buffering capacity of unstimulated saliva up to 10 minutes.
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Key Words: buffering capacity, pH, salivary flow, stimulated saliva, unstimulated saliva

Introduction

Dental caries is a transmittable infectious disease and *S. mutans* is considered one of the primary pathogens in its development because of acidogenic and aciduric properties. Also, dental caries is a multifactorial disease which starts with microbiological shifts within the complex biofilm and is affected by salivary flow and composition.[1,2] The signs of the carious demineralization are seen on the dental hard tissues, but the disease process is initiated within the bacterial biofilm (dental plaque) that covers a tooth surface.[1] After the exposure of the sugar, the decrease and subsequent increase in pH of dental plaque is known as Stephan curve.[3] Since fluid phase of dental plaque contains more calcium and phosphate than saliva, the critical pH for the fluid phase of dental plaque has been calculated to be as low as 5.1.[4] Once plaque is exposed to carbohydrate, its pH may decrease to as low as 4.0 within a few minutes, which leads to continued mineral dissolution until the plaque pH rises above the critical pH.[5]

The caries risks include physical, biological, environmental, behavioral, and lifestyle-related factors such as high numbers of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, poor oral hygiene, inappropriate methods of feeding infants, and poverty.[1] The saliva plays an important role in the neutralization of acids produced within the dental plaque and in the remineralization of demineralized enamel areas.[6] Many components in saliva are taken up preferentially by dental biofilm and protect the enamel surface.[2]

There are many researches about salivary flow, pH, and buffering capacity as a role of prevention against dental caries. Among them, dynamics of flow rate, pH, and buffering capacity before and after a meal seem to be important factors for the risk of caries. The purpose of this study was to evaluate the effect of the mastication for meal on flow rate and property of secreted saliva.

Materials and Methods

Subjects

Forty-six subjects were participated this research with informed consent. They were 29 males and 17 females (aged from 18 to 53, mean age 23.6 years) without any oral or systematic disease. The research protocol was approved by Ethical Committee of Faculty of Dentistry, Tokyo Medical and Dental University, Tokyo, Japan. Before the experiment, meal, smoking, oral rinse, and tooth brushing were prohibited for two hours. Each participant was examined oral condition and DMF-T was calculated. Experiment was started between 11 a.m. and noon.

Collection of saliva

The subjects were seated comfortably with eyes open, head tilted slightly forward.[7] For collection of stimulated whole saliva, spitting method was employed with chewing a piece of unflavored paraffin pellet as a stimulant for 5 minutes. Saliva was allowed to accumulate in the floor of the mouth and the subjects spitted it out into the graduated test tube. Amount of the saliva was measured and recorded. Then, each subject was instructed to rest for 5 minutes and to minimize orofacial movements after collecting the stimulated whole saliva.[7] Then unstimulatd saliva was collected from each subject by spitting method without any stimulant.

After collection of stimulated and unstimulated saliva, each subject had a meal which was a rice bowl and green tee. Time for meal was varied among 18 and 53 minutes (mean 23.6 minutes). The period of 0, 10, 20, 30, and 60 minutes after the meal, unstimulated saliva was collected by same method. The flow rate of saliva was calculated.

Evaluation of pH and buffering capacity

The pH and buffering capacity of the stimulated and unstimulated saliva were measured using a commercially available kit (Checkbuf, J. Morita, Kyoto, Japan).[8-11] After calibration at pH 4.0 and 7.0, an aliquot of 0.25 mL saliva was placed on the pH-sensor of a hand-held pH meter of Checkbuf and the initial pH value was directly measured. A vial of 0.25 mL lactic acid (15 mmol/L, pH 3.0) from the kit was titrated into the tested saliva sample and mixed using an automixer for 30 s. Further 0.25 mL saliva sample was added to the original saliva-acid solution and mixed for 30 s. Then the pH was measured and was determined as the salivary buffering capacity. Obtained data was statistical analyzed by the paired t-test ($p<0.05$).

Results

Flow rate, pH, and buffering capacity of stimulated saliva and unstimulated saliva at each period were shown in Figs. 1-3 respectively. Although flow rate, pH, and buffering capacity of the stimulated saliva varied among the subjects, they are higher than those of unstimulated saliva collected 30 minutes before a meal.

Despite no correlation between DMF-T and buffering capacity of stimulated saliva ($r=0.07524$, $r^2=0.0057$, $P=0.6192$), the correlation coefficient was statistically significant between buffering capacities of stimulated and unstumulated saliva collected before 30 minutes before a meal ($r=0.03227$, $r^2=0.1041$, $P=0.0287$).

The flow rate, pH, and buffering capacity of the unstimulated saliva collected just after meal (0 minute) was statistically higher than those before 30 minutes of meal. Twenty minutes after a meal and later, the flow rate, pH, and buffering capacity of the unstimulated saliva were statistically lower than those 0 minute and 10 minutes after a meal and showed no differences compared with the unstimulated saliva 30 minutes before a meal.

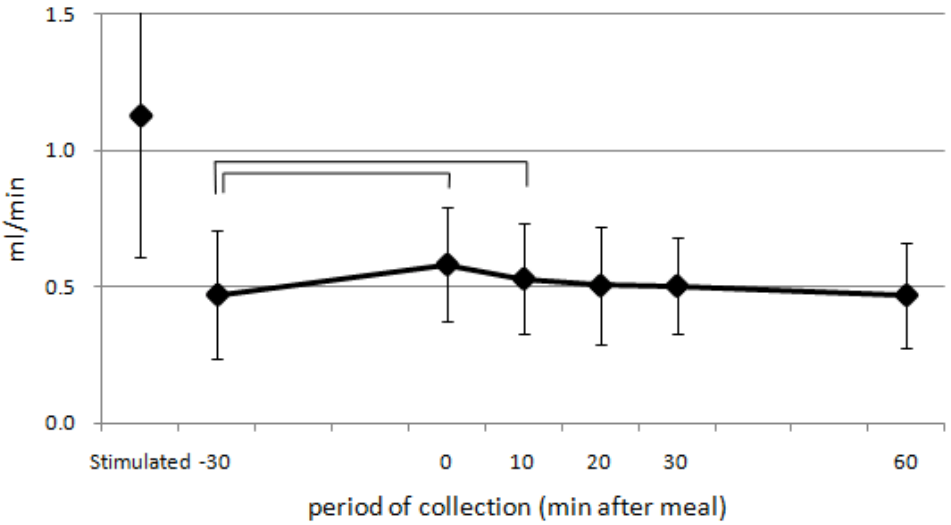

Fig. 1. Salivary flow rate of each period. Horizontal bars showed no statistical differences.

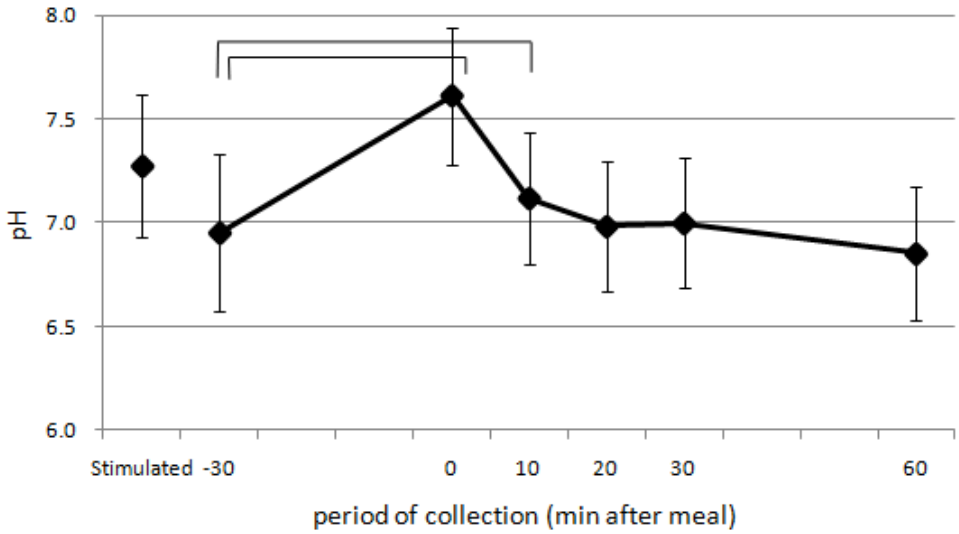

Fig. 2. The pH of each collected saliva. Horizontal bars showed no statistical differences.

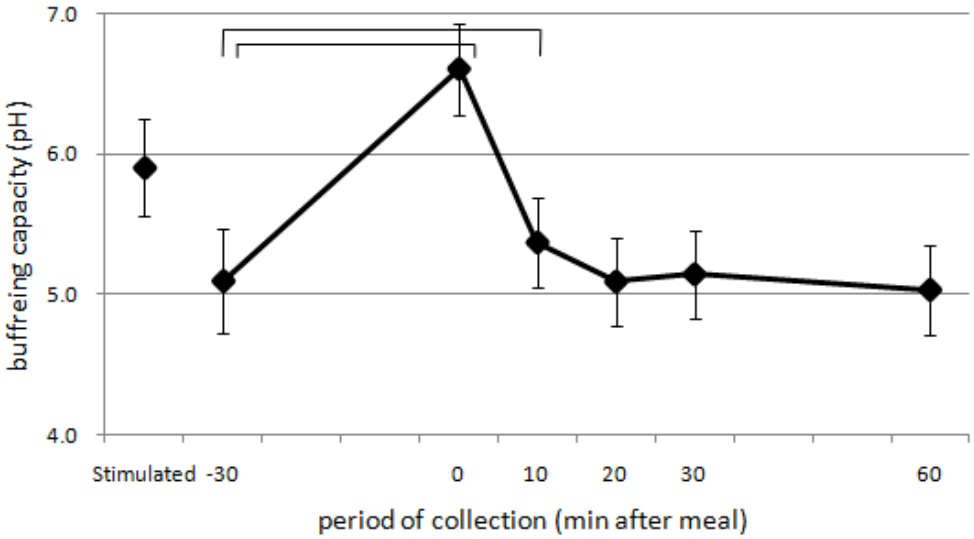

Fig. 3. Buffering capacity of each collected saliva. Horizontal bars showed no statistical differences.

Discussion

The multiple functions of saliva play a significant role in the prevention of dental caries.[6] Saliva is responsible for the acid clearance from dental plaque, which depends primarily on the velocity of the salivary film flowing over the plaque.[5] The ability of the biofilm to sequester calcium, phosphate, and fluoride from the saliva and exogenous sources allows enamel to undergo remineralization after periods of demineralization.[2]

The production of acids by microorganisms within the dental plaque continues until the carbohydrate substrate is metabolized.[2] It is also known that the pH of the plaque goes from acidic to normal or the resting level within a few minutes and depends on the presence of saliva.[3] This is due primarily to the carbonate and phosphate pH buffering agents in saliva.[6,12,13]

Saliva is constituted mainly by the secretions of the three paired major salivary glands: the parotid; submandibular; and sublingual. The minor salivary glands and the gingival fluid are also contributed to salivary secretions. Unstimulated whole saliva is the mixture of secretions that enter the oral cavity without exogenous stimuli. It is composed of secretions from both major and minor mucous glands but it also contains gingival crevicular fluid, desquamated epithelial cells, bacteria, leukocytes, and possibly food residues, blood, and viruses. Stimulated saliva is secreted in response to masticatory or gustatory stimulation.[14] The salivary flow rate is influenced by many factors, such as the degree of hydration, body position, exposure to light, previous stimulation, circadian and circannual rhythms, gland size, and drug use.[5,14] The period of 0 and 10 minutes after a meal, the unstimulated saliva showed higher flow rate, pH and buffering capacity than those of unstimulated saliva collected before 30 minutes of meal. However, there were no differences in flow rate, pH and buffering capacity among collected saliva before 30 minutes and 20, 30, and 60 minutes after a meal. Stimuli of mastication induced by the meal affected them up to 10 minutes, then gradually reducing. The higher level of salivary flow rate, pH, and buffering capacity immediately after meal may contribute to the prevention of the demineralization with the acid produced by oral bacteria with food.

Submandibular glands contribute for unstimulated saliva about 60%. When flow is stimulated, the parotid glands' contribution increases.[15,16] During sleep, the salivary flow rate is negligible.[17] Taste stimulation is a much more effective salivary stimulus than is chewing alone.[18] The effect of the gustatory stimulation induced by intake of foods is much more important than the mechanical stimulation by chewing in producing the flow of saliva. For optimal oral health, food and drink should remain in the mouth for as short a time as possible. The most important time for people to brush their teeth is just before bedtime, because salivary flow is negligible during sleep and the protective effects of saliva are lost.[5] From the results of this study, tooth brushing is also recommended after 20 minutes after a meal, since high flow rate, pH, and buffering capacity were maintained after 10 minutes of meal.

It was concluded that the stimulation of mastication for meal affected flow rate, pH, and buffering capacity of unstimulated saliva up to 10 minutes.

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