ORIGINAL RESEARCH

Evaluation of Flow Rate, pH, and Buffering Capacity of Saliva in Children with Caries, Fluorosis, and Caries with Fluorosis

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Abstract

Background: Saliva is one of the most important aids in the diagnosis of various oral diseases. Few physicochemical properties of saliva such as flow rate, pH, and buffering capacity often vary with the occurrence of dental caries, fluorosis, and other systemic conditions.

Purpose: The aim of the study was to evaluate the relationship between the salivary flow rate, pH, and buffering capacity in healthy children, children with caries, children with fluorosis, and children with both caries + fluorosis.

Materials and methods: The study population consisted of 144 children aged 7–14 years and were divided into four groups of 36 children each. Group I, 36 healthy children with no caries and fluorosis; group II, 36 children with caries (dmfs ≤ 10); group III, 36 children with fluorosis (moderate to severe); and group IV, 36 children with caries + fluorosis. Unstimulated saliva is collected from all the selected subjects and evaluated for the salivary flow rate, pH, and buffering capacity. The recorded data were tabulated and statistically analyzed using a paired *t*-test.

Results: The mean salivary flow rate and buffering capacity were found to be highest in group III when compared with all the other groups. The mean pH was greater in group I when compared with groups I, II, and III.

Conclusion: The physicochemical properties of saliva like pH, buffering capacity, and salivary flow rate alter with caries and fluorosis conditions. Hence, more clinical and laboratory studies are needed to determine the exact relationship between these physicochemical properties of saliva in dental caries and fluorosis.

Keywords: Buffering capacity, Dental caries, Fluorosis, pH, Salivary flow rate.

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Introduction

Saliva plays a critical role in maintaining dynamic equilibrium and achieving oral homeostasis. Saliva is an odorless, tasteless, slightly acidic viscous fluid presenting a diverse range of functions such as buffering action, lubrication, protection, maintenance of tooth, mucous membrane integrity, anti-microbial action, taste, and digestion. Saliva can be used as a diagnostic aid as it is considered as the "mirror" of the oral cavity.[1]

Saliva can be collected as stimulated or unstimulated saliva. Stimulated and Unstimulated saliva can be collected with or without masticatory or mechanical action or exogenous gustatory stimulation.[2] Despite the wide use of preventive measures, dental caries, and dental fluorosis in children always outrank other oral diseases in occurrence and result in the alteration of a few physicochemical properties of saliva.

According to some studies no consistent relationship exists between dental caries prevalence and salivary pH. The flow rate itself influences the salivary Na^+/HCO_3^- ratio, at higher flow rates there is an increased buffering capacity. Patients whose saliva has a higher buffering capacity tend to have less caries lesions.[3]

A buffer is a solution which helps to maintain a constant pH. Bicarbonates are by far the most important salivary buffer for several reasons. The importance of saliva as a buffer can be demonstrated by the pH of active carious lesions. Within an active carious lesion (dentin) a pH gradient exists. The key buffering agent in unstimulated saliva is inorganic phosphate whereas saliva carbonic acid or bicarbonates are major buffering agents in stimulated saliva. In the maintenance of salivary pH and dental remineralization in the oral cavity buffering capacity of saliva has a major role.[3]

Dental fluorosis causes hypomineralization of enamel which increases the porosity and results in the decay of the tooth. There is a paucity of evidence showing the relationship of fluorosis with the change in physicochemical properties which includes flow rate of saliva, pH of saliva, and saliva buffering capacity.[4] Hence, this study was conducted to know the flow rate of saliva, its pH, and buffering capacity in children with decayed teeth (caries), fluorosis, and children with both caries and fluorosis.

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Materials and Methods

This current study was undertaken in the Department of Pedodontics, Kamineni Institute of Dental Sciences, Nalgonda, Telangana, India along with the Department of Biochemistry, Kamineni Institute of Dental Sciences, Nalgonda, Telangana, India. Institutional Ethical Committee clearance and informed verbal consent from the participants were obtained before the commencement of the study. A sample of 144 children within the age group of 7–14 years

was recruited from walk-in patients of OPD in the Department of Pedodontics.

Inclusion Criteria

- Children with caries (dmfs ≤ 10).
- Children with fluorosis (moderate to severe).
- Children with both caries (dmfs ≤ 10), and fluorosis.
- Children with no evidence of fluorosis or caries.

Exclusion Criteria

- Children who were on medications were physically or medically compromised.
- Children who presented arrested carious lesions and chronic renal diseases.

The selected subjects were allocated into four groups with a sample of 36 children in each.

- Group I—Healthy children (control).
- Group II—Children with caries dmfs ≤ 10.
- Group III—Children with moderate to severe fluorosis.
- Group IV—Children with caries + fluorosis.

Collection of Saliva

The children were comfortably seated upright in a relaxed state on the pediatric dental chair.[5] A sterile plastic container was given to children for saliva sample collection. About 10 mL of unstimulated whole saliva was collected under physiological resting conditions. Children were asked to spit in the given plastic container once a minute for 10 minutes as described by Scully.[6] Once the samples were obtained they were stored in an ice box for transportation and for biochemical evaluation of the pH of saliva and its buffering capacity at the earliest.

Estimation of the Flow Rate of Saliva

The flow rate of saliva was estimated by asking children to spit into the pre-weighed plastic cylinders for 5 minutes. The plastic cylinders (containing saliva) were then weighed and the flow rate was determined and calculated as g/mL which is almost equivalent to mL/minute.

Estimation of pH and Buffering Capacity of Saliva

The pH of saliva was measured using a digital pH meter and the buffering capacity of saliva was by Ericsson method 1959. A 0.5 mL of saliva was added to 1.5 mL of 5 mmol/L hydrochloric acid (HCL). The mixture was vigorously shaken and allowed to stand for 10 minutes. A digital pH meter was used to analyze the obtained pH. The obtained results were statistically analyzed and tabulated by paired *t*-test by Statistical Package for the Social Sciences software version 19 for the physicochemical properties of saliva.

Results

In group I (healthy children), the mean salivary pH (Table 1) was 6.96 ± 0.54, group II (caries) was 6.74 ± 0.38; group III was 6.80 ± 0.48; and group IV was 5.7 ± 0.30. On intergroup comparison, the mean salivary pH was found to be significantly greater or higher in healthy children compared to children with caries, fluorosis, and caries + fluorosis. Group IV children (caries + fluorosis) had significantly lower mean pH of saliva than the other groups. However, no significant difference was seen between groups II and III.

The mean salivary buffering capacity (Table 2) of group I (healthy children) was 3.07 ± 0.74, group II (caries) was 2.66 ± 0.72; group III was 3.21 ± 0.82; and group IV was 1.99 ± 0.61. On intergroup comparison, the mean buffering capacity was found to be significantly greater in the fluorosis group when compared to children with caries, caries + fluorosis, and healthy children. However, groups I and III showed no significant difference between them.

Table 1: Descriptive statistics of mean salivary pH values obtained by the four groups

Groups	*Mean*	*Standard deviation (SD)*
Group I	6.96	0.54
Group II	6.74	0.38
Group III	6.80	0.48
Group IV	5.70	0.30

Table 2: Descriptive statistics of mean salivary buffering capacity values obtained by the four groups

Groups	*Mean*	*SD*
Group I	3.07	0.74
Group II	2.66	0.72
Group III	3.21	0.82
Group IV	1.99	0.61

Table 3: Descriptive statistics of mean salivary flow rate values obtained by the four groups

Groups	*Mean*	*SD*
Group I	0.35	0.09
Group II	0.32	0.11
Group III	0.55	0.18
Group IV	0.27	0.07

The mean salivary flow rate (Table 3) of group I (healthy children) was 0.35 ± 0.09, group II (caries) was 0.32 ± 0.11, group III was 0.55 ± 0.18, and group IV was 0.27 ± 0.07. On intergroup comparison, group III showed the highest flow rate of saliva with a significant difference from all other groups. However, no significant difference was observed between groups I and II.

Discussion

Saliva is an easily available and noninvasive diagnostic medium. Saliva is a heterogeneous fluid comprising proteins, glycoproteins, electrolytes, small organic molecules, and compounds transported from the blood that constantly bathes the teeth and the oral mucosa. Whole saliva represents a mixture of secretions from major to minor salivary glands together with the gingival fluid.[7] There are many varied factors in saliva that protect enamel, dentin, and cementum from caries development and facilitate remineralization. The ability of saliva to affect caries development is dependent upon the quantity, quality, and composition of secretions.[8] Saliva possesses antimicrobial components and a buffering agent that acts to protect and maintain oral tissues.[9]

The terms unstimulated saliva, when no exogenous or pharmacological stimulation is used, and stimulated saliva when secretion is promoted by mechanical or gustatory stimuli or by pharmacological agents.[10] Unstimulated saliva sample which was collected by the spitting method was used in this study as it was known that the stimulating the flow of saliva can alter its composition.[11,12]

The human mouth frequently comes in contact with food components with a pH that differs from normal salivary pH (6.5–7.5).

The buffering capacity of saliva tries to bring it back to normal pH as these components may cause erosion of teeth or damage to mucosal surfaces.[13] The concentration of various components of saliva is markedly affected by variation in salivary flow rate. The variation of salivary constituents over time may reflect hormonal factors, external influences, and systemic conditions. Previous investigations have shown that salivary flow rate fluctuates with circadian rhythm. Hence, in this study saliva was collected on the same day to avoid the circadian effect.

Elevated unstimulated flow rate of saliva, its pH, and salivary buffering capacity are associated with low caries prevalence. An interaction is seen between the flow rate of saliva and the ability to buffer the acids produced in the oral cavity.[14]

Saliva was collected by two methods, that is, the draining method and the spitting method. In the draining method, saliva is dripped off the lower lip and in the spitting method, subjects expectorate saliva into a plastic tube.[15]

In this study, a method given by Nazavesh and Kumar for assessment of salivary flow rate was used.[15] Salivary flow rate increased in subjects with fluorosis in our study. It is well documented in the studies given by Boros et al. in 1984, Martins-Gomes et al. in 2000 and Scully stated that decreased salivary flow rate is probably due to the consequence of hypo salivation. Flow rate and dental caries have an inverse relation in a study by Gopinath and AR in 2006.[16] Tulunoglu et al. in 2006,[17] have given contradictory results that caries activity was not correlated with the flow rate of saliva. The unstimulated flow rate average is 0.3–0.4 mL/minute but ranges are wide. Unstimulated flow rates of < 0.1 mL/minute are considered as evidence of hyposalivation.[10]

In this study, salivary pH was greater in control groups than in caries, fluorosis, and caries + fluorosis. Preethi et al. in 2010,[18] Prabhakar et al. in 2009[19] stated that salivary pH decreases in caries-active individuals. A varied level of pH occurs as stated by Dogra et al. 2013,[20] Fiyaz et al. in 2013.[21] Tulunoglu et al. has given that no correlation exists between salivary pH and caries activity.[17]

After evaluating the pH of salivary samples using a digital pH meter, these samples were then titrated with 0.5 mL of 5 mmol/L HCL to evaluate the buffering capacity. Nielin in 1978 estimated that the buffering capacity of saliva would be in the range of 3–30 mg/100 mL. Erickson concluded that the buffering capacity of saliva has an inverse relationship with the incidence of caries.[22]

Buffering capacity increases in individuals with Fluorosis as given by Martins-Gomes et al 2001.[23] Preethi et al. in 2010,[18] Prabhakar et al. in 2009,[19] Zhou et al. in 2007[24] has given that buffering capacity decreases in caries active individuals. Errickson in 1959 stated that a negative correlation exists with caries incidence. Karshan in 1939[25] has given that mean values are more in caries free group.

Conclusion

It was noticed in our study that the physicochemical properties like salivary pH, rate of flow of saliva, and buffering ability significantly vary in children with caries and fluorosis. The dental fluorosis group showed a significantly higher rate of flow of saliva and buffering ability when compared to healthy children (caries free), children with caries and caries + fluorosis children. This study confirmed the existent fact, that is, low pH in children with dental caries condition group compared to all other groups. However, studies with larger sample sizes are to be conducted to establish a proper relationship between the physicochemical properties of saliva in conditions of dental caries + fluorosis.

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