



Estimation of Salivary pH, Viscosity, Flow Rate in Children with and without Early Childhood Caries – An Observational Study

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Authors' contributions

This work was carried out in collaboration among all authors. Author DR designed the study, wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Authors PR and RG managed the literature searches and analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Background and Objectives: Early Childhood Caries (ECC) is a chronic disease of childhood affecting the primary dentition. It is also termed as nursing caries or baby bottle tooth decay. It has a multifactorial etiology and salivary parameters are considered as one of the important etiological factors of ECC. The present study was done to compare the salivary pH, flow rate and viscosity in children with and without ECC.

Materials and Methods: It is a cross-sectional observational study conducted at Saveetha Dental college and Hospitals. Children between 3-6 years were examined and 20 caries free, 20 children with ECC and 20 children with Severe ECC were recruited for the study. The examination and sample collection were done by a single qualified Pediatric dentist. The samples were collected and analysed for salivary pH, flow rate and viscosity.

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Results: The results showed that there were no statistically significant differences in salivary pH levels in children with and without ECC. Statistically significant difference was evident in salivary flow rate and viscosity in caries-free, moderate ECC and severe ECC children.

Conclusion:

1. There is no significant difference in salivary pH levels in children with and without ECC.
2. There is a significant difference in salivary flow rate and viscosity among caries free, moderate ECC and Severe ECC children
3. Higher flow rate and low viscosity results in reduced caries occurrence

Keywords: Early childhood caries (ECC); saliva; salivary pH; Salivary viscosity.

1. INTRODUCTION

Early Childhood Caries (ECC) is considered as a chronic and dynamic process of tooth demineralization, leads to irreversible damage to the tooth structure in children less than 71 months. [1-2] Severe Early Childhood caries (S ECC) is referred as atypical, rampant progression of dental caries and the diagnosis of S ECC is based on the age and the extent of decayed, missing and filled Tooth surfaces (dmfs) in primary dentition. [3] The prevalence of ECC varies between 1-12 in developed countries and the prevalence rate is high about 70% in less developed countries. [4] ECC develops as a white-spot lesion in the upper primary incisors along the gingival margin and later progresses to complete destruction of the crown. The maxillary incisors are commonly affected and the mandibular incisors are least affected due to the protection of tongue and saliva from salivary glands. [5] Since the progression of ECC cause pain, discomfort and reduced ability in chewing ability, leads to development of malnutrition. [6] ECC is considered to have a multifactorial etiological model, feeding patterns, Salivary characteristics, microbiological challenge and oral hygiene practices were considered as an important factor in the development and progression of ECC. [7-8]

Saliva is considered as a unique biological fluid with various functions namely, lubrication of oral tissues, anti-microbial properties, digestion, demineralization and remineralization cycle, and neutralization of acid and bases. [8] Saliva is the mixed glandular secretion from parotid, submandibular and sublingual. The saliva also contains secretions from minor salivary glands and gingival Crevicular fluids. The continuous presence of saliva in oral cavity throughout the day help to protect the teeth and oral tissue, hence explains the importance of saliva in development of dental caries. [9,10] Salivary factors namely physical properties such as pH,

flow rate, viscosity is considered as an important predisposing factor in initiation of ECC. [11-14]. If the critical factors of saliva such as pH, viscosity, flow rate are favourable, the saliva strengthens the Enamel appetite structure and prevent demineralization.

The pH of the saliva alters the plaque pH and hence plays an imperative role in preventing the initiation of ECC. Saliva removes the sugars and the acids produced by the bacteria from the mouth. Salivary flushing action is essential to clear the microorganism, hence salivary flow rate plays a crucial role in the development of ECC. The stimulated and unstimulated salivary flow rate plays a major role in salivary sugar clearance, which is related to volumes of saliva in the mouth before and after swallowing. In addition, Salivary flow rate helps in maintaining the salivary pH in alkaline state, thereby raise the pH of dental plaque previously reduced by exposure to sugar [15]. Bicarbonate-carbonic acid is the important buffers of saliva and it maintains the physiologic hydrogen ion concentration at the mucosal epithelial cell surface and the tooth surface [16]. Salivary viscosity is termed as resistance for the liquid to flow and lower the viscosity, faster the clearance of sugars from oral cavity. Clinically, saliva with normal viscosity appears as clear and watery, which is essential for food digestion and motor functions of chewing, swallowing and speaking. Whereas, increased viscosity of saliva appears as sticky and ropy, with reduced efficiency in clearance of sugars from oral cavity [17,18]. Therefore, salivary viscosity helps in self cleansing and reduce the risk of ECC [19].

Bagherian A et al evaluated salivary pH in children with and without ECC and stated that salivary pH levels were higher in caries free children [20]. On Contrary, Abbas MJ et al reported no difference salivary pH levels in children with and without ECC [21]. Baghherian et al and Muchandi et found that low salivary flow

rate could be a reason for development of ECC, whereas, Sharaaf et al and Abbas et al inferred no relation between salivary flow rate and ECC [20,22,23].

The most common reasons for alteration in the oral balance that cause demineralization may be explained by measuring the important salivary parameters. Evaluating the salivary parameters such as pH, flow rate and viscosity in children who are at high risk of developing ECC can pave the way to develop preventive measures that will target individual's specific needs. Due to the existence of varies results, the present study was an attempt to estimate the level of salivary pH, flow rate, viscosity, in the saliva samples of children with and without ECC and elucidate if any correlation exists between these parameters and ECC

2. MATERIALS AND METHODS

2.1 Study Design

The present study is an observational study conducted to compare the salivary pH, flow rate, viscosity levels in children with and without ECC. The protocol was reviewed and approved by the Ethical committee of Saveetha Dental College and Hospitals.

20 children with ECC, 20 children with Severe ECC were selected based on dmft index and 20 caries free children were recruited to participate in the study.

2.2 Inclusion Criteria

Children between 3-6 years of age.
Children free of any systemic illness and not on any medication for past 1 month.
Children, whose parents provided written informed consent to participate in the study.

A single qualified Pediatric dentist collected information regarding dietary and oral hygiene practices through a face-to-face interview with the parent/caretaker of the child. The dmfs index was assessed. The children were refrained from eating or drinking for 1 hr before the sample collection. The dental examination was performed in a dental chair, using a dental mirror and an explorer. In group I, children were considered to be caries free, Group II: ECC, Group III: S ECC based on AAPD Guidelines. The salivary samples were collected between 8.00 to 11.00 am to prevent circadian variation. Children who were exhibiting negative behaviour were excluded from the study, since the

behaviour of the child can influence the composition of saliva [24]. Hence, finally there were 20 children in each group. Unstimulated saliva was collected in sterile tube. The saliva was allowed to drip into the tube and allowed till it reach 5 ml without measuring the froth the quantity. Salivary pH was evaluated using digital pH meter. The salivary flow rate was obtained from the volume of saliva collected in the initial 5 min of saliva collection [25,26]. The viscosity of saliva was assessed using Ostwald viscometer (Aldrich Company).

2.3 Statistical Analysis

Data was collected and tabulated. Statistical analysis was done using SPSS software version 20.0. One way ANOVA was done to determine the difference in salivary pH, viscosity and flow rate between the groups. The level of significance was regarded as $p < 0.05$.

3. RESULTS

Table 1 shows the comparison of salivary pH levels of different groups. When comparing the salivary pH levels between the groups, it was evident that the salivary pH values in in the caries-free group was 7.41 ± 0.317 , ECC group was 7.52 ± 0.345 and S ECC group was 7.41 ± 0.235 . The difference was not found to be statistically significant ($p > 0.05$). Table 2 shows the comparison of salivary flow rates of different groups. When comparing the salivary flow rates between the groups, it was evident that the flow rate value in the caries-free group was 0.52 ± 0.12 , ECC group was 0.37 ± 0.07 and S ECC group was 0.17 ± 0.03 . The difference was found to be statistically significant ($p < 0.001$). Table 3 shows the comparison of salivary viscosity between the groups. When comparing the salivary viscosity levels between the groups, it was evident that the salivary viscosity values in in the caries-free group was 1.02 ± 0.12 , ECC group was 1.93 ± 0.07 and S ECC group was 2.93 ± 0.03 . The difference was found to be statistically significant ($p < 0.001$).

4. DISCUSSION

Saliva is a unique biological fluid and considered as a first line of defence against various disease of oral cavity. The role of saliva on the development of early childhood caries depends on the amount and its composition. It is of paramount importance to recognize and determine the role of saliva in the

Table 1. Comparison of Salivary pH values between the groups

Groups	N	Mean	SD	p value
Group I (Caries-free)	20	7.57	0.317	
Group B (ECC)	20	7.52	0.345	
Group C (Severe ECC)	20	7.41	0.235	0.492

*p value was evaluated using ANOVA. p value < 0.05 – Significant **

Table 2. Comparison of salivary flow rate values between the groups

Groups	N	Mean	SD	F Value	p value
Group I (Caries-free)	20	0.52	0.12		
Group B (ECC)	20	0.37	0.07		
Group C (Severe ECC)	20	0.17	0.03	0.728	<0.001*

*p value was evaluated using ANOVA. p value < 0.05 – Significant **

Table 3. Comparison of salivary viscosity between the groups

Groups	N	Mean	SD	p value
Group I (Caries-free)	20	1.02	0.12	
Group B (ECC)	20	1.93	0.07	
Group C (Severe ECC)	20	2.93	0.03	<0.001*

*p value was evaluated using ANOVA. p value < 0.05 – Significant **

demineralization and remineralization process of dental structures exposed to the oral cavity [10]. Saliva serves as a tool to predict an individual's risk for caries by analysing salivary parameters. This provides an individual based diagnosis and treatment planning and helps to utilize preventive measures based on individual caries risk. Hence, saliva is considered as an important diagnostic tool due to its ease of availability, non-invasive and less expensive [27-29]. Various caries risk assessment models were proposed with salivary analysis as a main component.

A total of 60 children had participated in the study, all of which were selected randomly, based on the fulfilments of the inclusion criteria. Unstimulated saliva was collected from the children and evaluated for pH, flow rate and viscosity. The pH was evaluated using digital pH meter, flow rate was assessed based on the volume of saliva collected in the initial 5 min of saliva collection. The viscosity of saliva was assessed using Ostwald viscometer

Analysis of salivary pH revealed no significant difference in pH values between the groups. The result is in accordance with the study done by Thaweboon et al. [30], Sharaf AA et al [23], Martínez-Pabón MC [31], Abbas MJ [21] and Jayaraj D et al. [32], where the authors found no significant difference in salivary pH levels in children with and without ECC. In contrast, Bagherian A [20], Muchandi S et al [22] and

Animireddy D et al. [33] inferred an increase in salivary pH levels in caries free children as compared to caries active children, whereas, Achmad H et al reported a highly acidic pH in group of children with ECC [34].

There was a significant difference in salivary flow rate between the groups ($p < 0.001$). Group I children had higher salivary flow rate, than Group II and Group III. Salivary flow rate plays an important role in flushing of debris and rapid clearance of sugars from oral cavity. Hence the increased salivary flow rate in caries-free children could be a protective factor and one of the reasons for lack of development of caries. The results obtained was similar to study done by Bagherain et al. [20], Muchandi S [22] and Kuriakose et al. [35], where the authors reported a decrease in salivary flow rate in children with ECC. On contrary, Abbas MJ et al [21] and Jayaraj D et al. [32] reported that, there was no difference in salivary flow rate in children with and without Early childhood caries.

There was a significant difference in salivary viscosity levels between the groups ($p < 0.001$). Group III children had highly viscous saliva as compared to Group II and Group I. Thick and ropy saliva reduce the salivary flow rate, which indirectly affects the clearance of food debris from the oral cavity. In addition, Kitada K et al stated that, highly viscous saliva affects the co-aggregation of bacteria and reduced clearance of

bacteria from the oral cavity [36]. Hence, highly viscous saliva among the SECC group could be one of the reasons for increased rate of caries in this group of children. The results obtained was in accordance to the study done by Kaur A [37], Tenovuo J [38] and Bachtiar EW [39]. The authors reported that the caries-free children had clear watery saliva and children with ECC had highly viscous saliva.

5. LIMITATION

Studies state that, threshold limit of salivary flow rate is specific to individual [37] and considering these values would not be ideal while screening patient. Seasonal variation of temperature can affect the flow rate of saliva, such as warmer temperature can reduce the salivary flow and cooler temperature could increase the salivary flow [40-42]. In addition, diet such as dietary products can affect the viscosity of saliva [43]. These parameters were not taken into account while collecting salivary samples. As these parameters can affect the salivary flow rate and viscosity, further studies are needed in near future with a larger sample size and by considering the above- mentioned parameters.

6. CONCLUSION

With the light of available evidence following conclusion can be drawn

1. There is no significant difference in salivary pH levels in children with and without ECC.
2. There is a significant difference in salivary flow rate and viscosity among caries free, ECC and Severe ECC children
3. Higher flow rate and low viscosity results in reduced caries occurrence

CONSENT

As per international standard, parental written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

This study has been approved by the Ethics board of the Saveetha Dental College and Hospitals. The agreement was registered through an informed consent endorsed by the Ethics Committee of the Saveetha Dental College and Hospitals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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