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CORRELATION BETWEEN DENTAL CARIES WITH SALIVARY FLOW, PH, AND BUFFERING CAPACITY IN ADULT SOUTH INDIAN POPULATION: AN IN-VIVO STUDY

Chitharanjan Shetty^{1*}, Mithra N. Hegde², Darshana Devadiga³

¹P G Student, Department of Conservative Dentistry and Endodontics, A. B. Shetty Memorial Institute of Dental Sciences, NITTE University, Mangalore, Karnataka, India

²Senior Professor and Head of the Department, Department of Conservative Dentistry and Endodontics, A. B. Shetty Memorial Institute of Dental Sciences, NITTE University, Mangalore, Karnataka, India

³Professor, Department of Conservative Dentistry and Endodontics, A. B. Shetty Memorial Institute of Dental Sciences, NITTE University, Mangalore, Karnataka, India

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*Corresponding author

E-mail: drcmshetty@gmail.com

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ABSTRACT

Aim of the study is to evaluate the correlation between dental caries and salivary flow, pH and buffering capacity in young adult South Indian population. According to DMFT scores eighty subjects between 20 to 30 years of age were divided into four groups. Saliva samples collected were estimated for salivary flow, pH and buffering capacity and the data was statistically analysed. The pH, flow rate, buffering capacity showed a steady decrease with an increase in the DMFT values; which was statistically significant. The salivary flow, pH and buffering capacity increases with decrease in caries activity.

Keywords: Dental caries, Saliva, DMFT.

INTRODUCTION

Saliva is an important body fluid that is often neglected by dentists and ignored by physicians. Saliva is the least known and least appreciated of all body fluids in the human body. Saliva is produced in and secreted from salivary glands¹. The basic secretory units of salivary glands are clusters of cells called as Acini. These cells secrete a fluid that contains water, electrolytes, mucus and enzymes, all of which flow out of the acinus into collecting ducts². The composition and secretion of saliva is altered within the duct. Potassium is secreted, most of the sodium is absorbed and plenty of bicarbonate ions are secreted³.

Whole saliva is a composition of exocrine derivatives from major and minor salivary glands and a variety of non-exocrine components⁴. Various components of saliva play individual roles in the total properties of saliva. Salivary flow, pH and buffering capacity play an important role in the initiation and progression of dental caries⁵.

Parotid gland as a serous gland produces a thin, watery and amylase rich saliva; and accounts for up to half of the volume of stimulated saliva. Majority of un-stimulated saliva is contributed by submandibular gland which contains both serous and mucous acinar cell types⁶. Submandibular gland secretes more viscous, mucin-rich saliva compared to parotid gland. Around 1-2% of un-stimulated saliva is contributed by sublingual gland which secretes more viscous and mucin rich saliva. Less than 10% of total volume of saliva is contributed by minor salivary glands.

The important aspects of saliva that plays in protecting against the dental caries are flow, pH and buffering capacity.

There is greatest variability of salivary flow rates. Salivary flow during sleep is nearly zero. Stimulated saliva contributes as much as around 80% to 90% of average salivary daily production. Salivary flow is not even throughout the mouth. There is regional variation throughout the intra oral sites. The highest flow has been observed in the mandibular lingual area and the least flow was documented at the maxillary anterior and interproximal areas. The areas of higher and lower volume flow regions have been referred as 'salivary highways and byways'. The regional clearance rate of acid produced by bacteria is directly influenced by regional variation of flow in the mouth.

Buffering action and pH are other factors which control dental caries. An important buffering system is bicarbonate; which diffuses into the plaque and acts as a buffer by neutralising the acids. Since it generates ammonia from amines, which neutralises the acids, it serves as a buffer. During stimulated high flow rates the buffering action of saliva works efficiently; during low flow with un-stimulated saliva, it is almost ineffective.

The salivary pH may not be as important a measure for buffering action on caries as the pH of plaque, which modifies the saliva. The fermentable carbohydrates and the buffering capacity of saliva affect plaque pH, unless the pH of plaque is too low for enzymatic action of bacteria. The lowest level of pH of plaque might be 6.1 or even lower, approximately 15 minutes after food consumption.

Dental caries is one of the most common microbial infection, but rarely a critical disease⁶. Caries is characterized by a localized, transmissible, microbial infectious process that ends up in the destruction of hard dental tissue⁷. There are many factors which can cause

dental caries; among which, poor dental hygiene and oral care, family history of dental caries, greater concentration of bacteria in oral cavity with acidophilic activity, decreased salivary flow, more cariogenic diet and reduced level of fluoride in drinking water are the important factors⁸.

MATERIALS AND METHODS

The OPD of Department of Conservative Dentistry and Endodontics had total 21783 patients during the study period, from May 2011 to April 2012, who were from Karnataka, Kerala and Tamil Nadu states. Study was carried out as per Ethical Clearance no ABSM/EC/120/2010 Dated: 26/10/2010. Both the caries active and caries free subjects under the age group of 20 to 30 years were screened after the approval of Institutional ethical committee. Out of these 80 patients who were fulfilling the inclusion criteria and exclusion criteria were selected for the study. The patients fulfilling the inclusion criteria were free from systemic and local disease which affects salivary secretions and their caries status was assessed according to WHO criteria⁹. Patients with periodontal disease, hypertension, diabetes, radiotherapy and chemotherapy, systemic disease of the vital organs and history of long term medications were excluded from the study. A detailed case history of the subject was taken. A case history format was filled with an informed consent which was duly signed by the subject.

The smooth occlusal surfaces of the teeth were cleaned with soft bristle brush, dried and examined. DMFT score was calculated. Based on the DMFT scores, the study groups were divided as follows: Control group (Group I) consists of 20 healthy subjects which were caries free. The caries active groups contains as follows: Group II consists of 20 adults with DMFT 1-5, Group III consists of 20 subjects of DMFT 6-10 and Group IV with 20 adults of DMFT above 10.

Un- Stimulated (resting) saliva samples were collected according to Dawe's method (1993)^{10,11}. Subjects were asked to abstain from smoking, brushing of teeth, use of mouth wash, eat or drink for 1 hour prior to the collection of sample. Samples were collected between 10 to 11am. During sample collection the subjects were seated in a normal chair instead of the dental chair to maintain a stress-free environment. The un-stimulated saliva was

collected by asking the subjects to pool the saliva on the floor of the mouth and then made to expectorate it into a collection cup. Collected saliva was refrigerated at -10 degree centigrade till the evaluation of SIgA and SIgG done¹².

For collection of stimulated saliva the patient was asked to chew paraffin wax to stimulate the salivary flow. After 30 seconds patient expectorated into the spittoon and continued chewing for further 5 minutes. Saliva was collected in a collection cup at regular intervals of time. Total volume of saliva collected was noted and divided by 5 to obtain the flow rate of saliva in ml/min.

The flow rate, pH and buffering capacity were estimated using GC Saliva Check Kit (GC Asia Dental Pvt. Ltd., Singapore, 508724). For pH evaluation a pH test strip was immersed in the un-stimulated saliva for 10 seconds and compared for colour change with a testing chart.

The buffer strip was removed from the foil package and placed onto an absorbent tissue with the test side up. Using pipette, sufficient saliva was drawn from the collection cup and dispense one drop onto each of the 3 test pads. Immediately the strip was turned around to 90 degree to soak up excess saliva on absorbent tissue. (This is to prevent the excess saliva from swelling on the test pad and possibly affect the accuracy of the result). The test pads was begun to change the colour immediately and after 2 minutes the final result can be calculated by adding the points according to the final colour of each pad.

The salivary parameters such as pH, buffering capacity, flow rate from all the groups were calculated from the saliva samples and correlated to the DMFT index. The data collected was statistically analyzed with One Way ANOVA and Tukey's HSD test using STATA Version 12 software.

RESULT

A steady decrease in flow rate was seen from Group (G) I to IV with mean values of 1.52ml/min, 1.73ml/min, 0.94ml/min and 0.74ml/min respectively.

Inter group comparison between the experimental groups using Posthoc analysis by Tukey's HSD test showed that the decrease in Flow rate was not Significant [NS] between G I and II ($p > 0.05$), Significant [S] between G III and IV ($p < / = 0.05$) and Highly Significant [HS] between all other groups ($p < / = 0.001$). (Figure 1, Table 1 and 2, Graph 1)

Table 1: Comparing the values of flow rate, pH and buffering capacity level in caries free and caries active groups

		N	Mean	Std. Deviation	Mean Square	F	Significance
pH	DMFT - 0	20	7.30	0.29	12.431	84.658	<0.001
	DMFT 1-5	20	6.88	0.30			
	DMFT 6-10	20	5.92	0.52			
	DMFT>10	20	5.63	0.38			
	Total	80	6.43	0.78			
Flow rate	DMFT - 0	20	1.52	0.16	2.327	85.886	<0.001
	DMFT 1-5	20	1.36	0.15			
	DMFT 6-10	20	0.94	0.19			
	DMFT>10	20	0.80	0.15			
	Total	80	1.15	0.34			
Buffering Capacity	DMFT - 0	20	11.10	0.97	108.183	60.903	<0.001
	DMFT 1-5	20	10.20	0.77			
	DMFT 6-10	20	8.60	1.64			
	DMFT>10	20	5.80	1.70			
	Total	80	8.93	2.41			

Table 2: Comparing the values of flow rate, pH and buffering capacity level in caries free and caries active groups on inter group comparison

Multiple Comparisons					
Tukey HSD					
Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Significance
pH	DMFT - 0	DMFT 1-5	.4200	.1212	.005
		DMFT 6-10	1.3850	.1212	<0.001
		DMFT>10	1.6700	.1212	<0.001
	DMFT 1-5	DMFT - 0	-.4200	.1212	.005
		DMFT 6-10	.9650	.1212	<0.001
		DMFT>10	1.2500	.1212	<0.001
	DMFT 6-10	DMFT - 0	-1.3850	.1212	<0.001
		DMFT 1-5	-.9650	.1212	<0.001
		DMFT>10	.2850	.1212	.095
flow rate	DMFT - 0	DMFT 1-5	.1650000	.0520501	.012
		DMFT 6-10	.5800000	.0520501	<0.001
		DMFT>10	.7250000	.0520501	<0.001
	DMFT 1-5	DMFT - 0	-.1650000	.0520501	.012
		DMFT 6-10	.4150000	.0520501	<0.001
		DMFT>10	.5600000	.0520501	<0.001
	DMFT 6-10	DMFT - 0	-.5800000	.0520501	<0.001
		DMFT 1-5	-.4150000	.0520501	<0.001
		DMFT>10	.1450000	.0520501	.033
Buffering Capacity	DMFT - 0	DMFT 1-5	.900	.421	.151
		DMFT 6-10	2.500	.421	<0.001
		DMFT>10	5.300	.421	<0.001
	DMFT 1-5	DMFT - 0	-.900	.421	.151
		DMFT 6-10	1.600	.421	.002
		DMFT>10	4.400	.421	<0.001
	DMFT 6-10	DMFT - 0	-2.500	.421	<0.001
		DMFT 1-5	-1.600	.421	.002
		DMFT>10	2.800	.421	<0.001

Figure 1: Comparing the flow rate in caries free and caries active groups **Figure 2: Comparing the pH values in caries free and caries active groups** **Figure 3: Comparing the buffering capacity in caries free and caries active groups** **Graph 1: Comparing the values of flow rate level in caries free and caries active groups**

Graph 2: Comparing the values of pH level in caries free and caries active groups

Graph 3: Comparison of buffering capacity in caries free and caries active groups

A steady decrease in pH values was seen from Group I to IV with mean values of 7.3, 6.88, 5.89 and 5.63 respectively.

Inter group comparison between the experimental groups using Post-hoc analysis by Tukey's HSD test showed that the decrease in pH was Significant between G I and II ($p \leq 0.05$), Not Significant [NS] between G III and IV ($p > 0.05$) and Highly Significant [HS] between all other groups ($p \leq 0.001$). (Figure 2, Table 1 and 2, Graph 2)

A steady decrease in buffering capacity was seen from G I to IV with mean values of 11.1, 10.2, 8.6 and 5.8 respectively. Inter group comparison between the experimental groups using Posthoc analysis by Tukey's HSD test showed that the decrease in buffering capacity was Not Significant [NS] between G I and II ($p > 0.05$) but Highly Significant [HS] between all other groups ($p \leq 0.001$). (Figure 3, Table 1 and 2, Graph 3).

DISCUSSION

Saliva is a mixture of parotid, submandibular, sublingual and minor salivary glands. One of the important factor that controls the dental caries is salivary flow. Salivary flow helps in self cleansing property of saliva^{13,14}. Salivary flow is regulated by many factors. Salivary flow can be dependent on sensory stimulation, stress, body positioning, degree of hydration, food ingestion, drugs and smoking etc. The most dramatic effect on salivary flow is seen in radiation therapy patients for head and neck diseases.

The results of the present study showed that the salivary parameters in the saliva of young healthy adults of the age group of 20 to 30 years such as pH, flow rate, buffering capacity which showed a steady decrease with an increase in the DMFT values; and was statistically significant. These results were in agreement to previous studies conducted by Rovelstad et al¹⁵.

During resting salivary flow is only to keep the mouth moist and lubricate the mucous membrane^{16,17}. Generally, greater the flow rate, better the cleansing action of saliva on tooth surface¹⁸ hence, lesser the chance of dental caries. The results suggest the lesser DMFT status could be having similar flow rates. The results of the present study states that the increase in salivary flow rate resulted in decreased caries incidence. These are in agreement with a study conducted by Browne et al and Scully which

stated that dental caries is a common consequence of decreased flow rate. In contrast, a study by Birkhed, Heintze and Russell et al stated that there is no correlation between salivary flow rate and dental caries.

The pH of saliva is an important component to maintain the integrity of oral cavity¹⁸. However, the pH increases the remineralisation of tooth surface because of the increased degree of super saturation. The acidic pH can cause the maximum incidences of dental caries¹⁹. It has been well documented that the dissolution of enamel occurs when the pH falls below critical pH²⁰ i.e. 5.5, so the data obtained in group IV were approaching the critical value, which resulted in higher DMFT values.

The determination of buffering capacity of saliva helps to establish the role of buffer system in tooth integrity. In this study, on inter group comparison; there was a steady decrease in the values and slight variation was observed amongst group I and II. This could be because of pathogenic microorganisms and other salivary factors which can result in variation. The group IV had lowest buffering capacity and higher values of DMFT concluding that buffering capacity had a strong correlation with dental caries. The study conducted by Johansson I et al and Saelbtröm A-K et al²¹, showed that, the decreased buffering capacity due to more acidic pH, resulted increased incidence of dental caries, which supports the present study. Also the study conducted by WG Young et al states that the decreased buffering capacity causes the demineralisation of the tooth structure which results in dental caries, which supports our present study.

The age group which was selected for the present study was of young adults in between 20-30 yrs, which is the age group having complete permanent dentition with eruption of third molars. In today's world, eating habits of younger population has noticed a drastic change. Habits such as tobacco chewing, smoking etc. have become more prevalent these days which have deleterious effects on the oral environment. The effects range from changes in the salivary composition to oral diseases. Hence, the present study focuses on the evaluation of the relationship between dental caries and salivary components in younger adult population. Further study is recommended with broader age groups and periodontal condition as consideration.

CONCLUSION

Salivary flow, pH and buffering capacity are contributory factors in maintaining the integrity of oral cavity. The increase in these factors can result in decrease in the caries activity. This study is done in young adults in South Canara population. It can be further included for South Indian population.

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