Original Article

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Dentistry Section

Correlation of Salivary pH, Incidence of Dental Caries and Periodontal Status in Diabetes Mellitus Patients: A Cross-sectional Study

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ABSTRACT

Introduction: Diabetes mellitus is a chronic disease affecting many parts of the body. A number of oral diseases have been associated with diabetes mellitus with an increased risk of dental caries and periodontal disease.

Aim: The aim of the study was to evaluate the salivary pH and incidence of dental caries and periodontal status in diabetes mellitus compared to that of the normal subjects.

Materials and Methods: The study population consisted of 40 patients divided into 2 groups with group I comprising of 20 known diabetes mellitus patients and group II comprising of 20 non diabetic subjects as control group. The pH of the saliva was determined using a digital pH meter. Dental caries and periodontal status were assessed by DMFT and PDI indices respectively.

Results: There was a decrease in the mean salivary pH of 6.51 in the study group, compared to the normal mean salivary pH of 7.88 in the control group. The mean DMFT index was higher in the study group (8.10) when compared to that of control group (1.15). The mean PDI score was also higher in the study group (4.0) as compared to that of the control group (0.45).

Conclusion: The results of the present study concluded that there was a significant relationship between the diabetes mellitus and increased incidence of dental caries and periodontitis and there was also a significant reduction in the salivary pH in diabetes mellitus patients, compared to that of non diabetic subjects.

Keywords: Systemic diseases, Salivary biomarkers

INTRODUCTION

Diabetes mellitus is a global health challenge faced by the world today. India ranks second with 66.8 million people with diabetes in 2014 following China which ranks first with 96.2 million diabetics. International Diabetes Federation estimates that currently, more than 387 million people worldwide have diabetes and it is estimated to increase to 592 million by 2035 [1]. It is a common chronic metabolic disease with various oral consequences. Diabetes mellitus manifests in altering the salivary composition and its functions. Change in oral environment initiates pathogenic bacteria, damaging hard and soft tissues of the oral cavity leading to an increased cariogenic activity and periodontal lesions. Since, saliva provides a protective effect; there can be development of dental caries when there is clinically significant decrease in salivary functions [2].

Alterations in pH of saliva are often reported in diabetes mellitus patients. There is often a correlation between pH changes in plaque and sugar clearance from saliva [3]. The low salivary pH provides an acidogenic environment for the growth of aciduric bacteria leading to dental caries which again further lowers the salivary pH leading to a vicious cycle. Diabetes promotes periodontitis through an exaggerated inflammatory response to the periodontal microflora [4].

AIM

The aim of this study was to evaluate pH of saliva in diabetes mellitus patients and to compare with that of normal subjects and also to evaluate the caries incidence and periodontal status of the diabetes mellitus patients and compare it with normal subjects.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Oral Medicine and Radiology, Chettinad Dental College and Research Institute where a total of 40 subjects were included after taking the institutional ethical clearance and informed consent from the subjects. The subjects were divided into two groups. Group I (study group) comprised of 20 known diabetic patients (6 males and 14 females), with a fasting blood glucose more than 121mg/dl, with minimum of two years of disease duration. Both the Type 1 and Type two diabetic patients were included in this group. Group II (control group) comprised of 20 non diabetic patients (4 males and 16 females), who were age and gender matched as that of the previous group. The exclusion criteria included subjects who did not give written informed consent, gestational diabetic patients and patients with the habit of smoking. A detailed history of the patient was taken including personal history, drug history, allergies. The patients were clinically examined and assessed for dental caries and periodontal status using the Decay, Missing, Filled, Treatment (DMFT) index and Periodontal Disease Index (PDI) respectively. The blood samples were collected to estimate the fasting and postprandial blood glucose levels. The unstimulated whole salivary samples were collected from subjects in both the groups using spitting method, after a waiting period of 10 minutes, so as to avoid sample dilution before collecting the subjects were asked to bend the head forward and accumulate the saliva in the floor of the mouth and expectorate it in a sterile container, every five minutes for15 minutes. The pH of the samples was immediately analysed using a digital pH meter "pH Tester 10, 20, 30, 10 BNC, Spear".

RESULTS

In the present study, 20 diabetic (study group) and 20 non-diabetic (control group) subjects participated. [Table/Fig-1] depicts the comparison of mean salivary pH, DMFT and PDI among diabetic patients and non-diabetic patients, the salivary pH was low (6.5) among the study group compared to the control group (7.89) and the mean DMFT (8.1) and PDI (4) score were high in diabetic patients than non-diabetic patients whose DMFT and PDI score were 1.15 and 0.45 respectively. Independent sample t-test showed that there was a highly significant difference in the mean score between the

study group and the control group, with a p-valve of <0.05, which was statistically significant.

[Table/Fig-2] depicts the correlation between the salivary pH, DMFT and PDI among the study group, a significant negative correlation (r = -0.52) was observed between the salivary pH and DMFT among diabetic patients.

[Table/Fig-3] depicts the correlation between the salivary pH, DMFT and PDI among the control group, no significant correlation observed between the salivary pH, DMFT and PDI among non-diabetic patients.

Parameter	Group	N	Mean	Std. Deviation	t- value	p-value
SALIVA pH*	DM*	20	6.5	0.71692	7.95	0.00
	NDM*	20	7.89	0.279117		
DMFT*	DM*	20	8.1	5.875	5.13	0.00
	NDM*	20	1.15	1.461		
PDI*	DM*	20	4	1.589	9.33	0.00
	NDM*	20	0.45	0.605		

[Table/Fig-1]: Comparison of mean salivary pH, DMFT and PDI between Diabetic and Non- Diabetic Patients.
*Independent Samples t-test, (p<0.05 – Statistically Significant)

Diabetic Patients	DMFT*	PDI
Saliva pH*	-0.52*	-0.09

[Table/Fig-2]: Correlation between Salivary pH with DMFT and PDI among Diabetic Patients.
*Pearsons correlation (p<0.05)

Non -Diabetic Patients	DMFT*	PDI*
Saliva pH*	-0.065	-0.35

[Table/Fig-3]: Correlation between Salivary pH with DMFT and PDI among Non-Diabetic Patients.
* Pearsons correlation

DISCUSSION

Diabetes mellitus is a common chronic metabolic disease with numerous oral and systemic manifestations. Oral manifestations of diabetes mellitus includes dental caries, salivary dysfunction, oral mucosal and other oral infections, taste and neurosensory disorders, gingivitis, periodontitis etc., [5]. This study evaluates the salivary pH, incidence of dental caries and periodontal status of diabetes mellitus patients and compares them with normal subjects. Saliva has a normal pH range of 6.2-7.6 with an average of 6.7 [3]. In the oral cavity, the pH is maintained near neutrality (6.7-7.3) by saliva. The saliva maintains the pH by two mechanisms. First the flow of saliva eliminates the carbohydrates which could be metabolized by the bacteria hence the acid produced by the bacteria is removed. Second, the buffering activity of saliva neutralizes the acidity formed from food and drinks, as well as from the microbial activity [3]. In the present study un-stimulated saliva samples were collected from diabetes and non-diabetes patients as the composition and pH may alter in stimulated salivary samples for determining the salivary pH [6].

The mean salivary pH was compared among the diabetic and non-diabetic. Diabetes mellitus subjects had decreased salivary pH when compared to that of control group [Table/Fig-1]. This may be attributed to the metabolic changes in diabetes mellitus patients resulting in acidic pH. In diabetes, there is reduction in the level of bicarbonates in all body fluids which leads to metabolic acidosis of all body fluids. This explains the acidic nature of the saliva in patients with diabetes mellitus [7]. Patients with diabetes mellitus had increased DMFT score when compared to the control group [Table/Fig-1]. This is due to loss of protective mechanism of the saliva in diabetics. The cleansing and buffering action of saliva is also impaired. Low salivary pH promotes the growth of aciduric bacteria which then allows the acidogenic bacteria to proliferate creating an inhospitable environment for the protective oral bacteria. This allows for a shift in the oral environmental balance to favour cariogenic bacteria, which further lowers the salivary pH and the cycle continues [8]. Cariogenic bacteria are likely to thrive in acidic environment. Other risk factors such as increased blood glucose levels, reduced salivary flow rate, buffering capacity, poor dietary control also increases the risk of dental caries in diabetes mellitus patients.

The present study is in accordance with studies done by Deepak Goyal et al., Ciglar et al., Rai K et al., Elkafri et al., who have reported decreased salivary pH and increased dental caries among diabetes mellitus patients [8-11]. Studies by Sadia Iqbal et al., Jawed et al., Akapata et al., have reported increased incidence of dental caries among diabetes mellitus patients [12-14]. In contrast, studies by Collin HL et al., and Alves C et al., reported that no differences were found in the DMFT score among diabetics and non-diabetics [15,16].

When the periodontal status was compared, patients with diabetes mellitus had increased occurrence of gingivitis and periodontitis than the non-diabetic control group [Table/Fig-1]. Diabetes increases the risk of gingivitis and periodontitis. One of the major complications of diabetes is change in the microvascular integrity. In diabetes mellitus, chronic and prolonged hyperglycaemia leads to high levels of accumulation of irreversibly glycated proteins called Advanced Glycation End Products (AGEs) in the tissues including periodontium. Changes in the collagen stature, altered immune function have been reported. The changes in collagen stature, altered immune function and accumulation of AGEs in the periodontium causes impaired polymorphonuclear leukocyte function which may facilitate bacterial persistence in the tissues. Interactions between AGEs and inflammatory cells lead to increased production of proinflammatory cytokines such as IL-1β and TNF-α, which leads to an increase in collagenase activity and reduction in collagen synthesis which affects the collagen metabolism [17-20]. This results in compromised wound healing and increased periodontal tissue destruction in diabetes mellitus patients. This study is in accordance with study done by Poplawaska-Kita A et al., who reported that there was an increased risk of periodontitis in patients with diabetes mellitus [21]. Also, the reduction in salivary pH which was evident in our study may increase the growth of periodontal-pathogens which is in accordance with that of Takahashi et al., Fujikawa et al., and Galgut [22-25].

Negative correlation was found between salivary pH & DMFT and between salivary pH & PDI, [Table/Fig-2] which suggests that when the pH of the saliva is decreased (acidic), there is increased incidence of dental caries. This result is in accordance with the study done by Michelle Hurlbutt et al., who reported that low salivary pH promotes cariogenic lesions in the oral cavity [26]. Similarly, pH of saliva in patients with periodontitis is more acidic than control group [Table/Fig-2], which is similar to the study done by Sharmila Baliga et al., who reported that pH of saliva in patients with chronic generalized periodontitis was more acidic than pH of saliva of the control group [3]. This can be explained in accordance with the study conducted by Takahashi et al., that the microorganism which are responsible for periodontitis have a favourable environment for growth in an acidic pH such as *P. gingivalis* grows at a pH of 6.5-7.0, *P. intermedia* grows at a pH of 5.0-7.0 and *F. nucleatum* grows at a pH of 5.5-7.0 [22,23].

LIMITATION

In this study the blood glucose values were taken without any alteration in the medications which may influence the values of the results. This could be a limitation to our study but this was not taken into consideration as the disease is a chronic condition.

CONCLUSION

The present study concludes that patients with diabetes mellitus have reduced salivary pH, increased incidence of caries and periodontitis when compared to the control group. The pH of the

saliva in patients with an increased DMFT and PDI score was more acidic than the patients with low DMFT and PDI score.

Diabetes mellitus has been consistently documented to be associated with altered salivary composition and function which disrupts the homeostasis of the oral cavity. This predisposes them to various oral ailments including dental caries and periodontitis. As salivary diagnostics is an emerging field, pH of saliva can be used to evaluate the severity of dental caries and periodontitis in diabetes mellitus patients. Saliva can be used as an indicator of prognosis during periodontal treatment. Prevention and management of oral complications in patients with diabetes and promotion of oral health is important due to their possible adverse effects on glycaemic control.

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