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The detection of salivary glucose, caries and periodontal status in diabetes mellitus patients

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Original Article

Abstract

BACKGROUND AND AIM: Oral manifestations in diabetic patients can have different causes. Possibly, one of these causes is salivary glucose. The aim of this study was to evaluate salivary glucose concentrations in patients with Type II diabetes mellitus (DM) and their association with oral and dental manifestations and compare them with normal adults.

METHODS: In this analytical study, 128 patients with Type II DM and 132 non-diabetic healthy individuals were selected. The subjects' blood and unstimulated salivary samples were collected. Salivary glucose concentrations were measured by glucose oxidase method. Then, the oral cavity and teeth were examined for oral manifestations such as ulcers, white and red plaques, lichenoid reaction, candidiasis and decayed missing filled teeth (DMFT) and periodontal disease index (PDI) indices. Data were analyzed by independent t-test and Pearson's correlation test.

RESULTS: The results of the present study showed that, in general, individuals with higher concentrations of salivary glucose had significantly higher DMFT and PDI, irrespective of belonging to the diabetic or the control group ($P < 0.050$). However, there was no significant correlation between salivary glucose concentrations and oral manifestations. Meanwhile, there was a significant correlation between salivary glucose concentration and glycated hemoglobin in diabetic patients compared with the control group ($P < 0.001$).

CONCLUSION: The present study showed that the salivary glucose concentration had a positive association with DMFT and PDI in diabetic and non-diabetic patients. In this study, we found an association between salivary and blood glucose in diabetic patients.

KEYWORDS: Diabetes Mellitus, Decayed Missing Filled Teeth, Oral Manifestation, Periodontal Disease Index, Salivary Glucose

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Diabetes mellitus (DM) is a metabolic disorder that can have many oral manifestations, including xerostomia, bacterial, viral and fungal infections, poor wound healing, tooth cavities, gingivitis, periodontitis, periapical abscesses and burning mouth syndrome.[1] Increased fluid excretion, lowered response to infections, microvascular changes and possibly increased salivary glucose concentrations can be found in DM patients.[2] Worldwide, researchers are interested in using saliva as a diagnostic fluid that contains proteins, enzymes, hormones and carbohydrates; in addition, this fluid is readily available.[3] Glucose is a small

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molecule that easily penetrates via vessels and is transported from serum to gingival fluids and enters saliva.[4]

Investigations on salivary and blood glucose have shown varying results regarding the concentration of blood and salivary glucose between DM patients and healthy individuals.[3-7] Several studies have not shown an association between blood and salivary glucose,[3,4] whereas others have shown a statistically significant association between blood and salivary glucose.[5-7] Most investigations on salivary glucose have focused on its relationship with the blood glucose concentration as well as its association with oral manifestations in diabetic patients. None of the previous investigations has reported an association between either blood or salivary glucose and a higher number of tooth cavities and other oral manifestations in healthy individuals. Therefore, the aim of the present study was to investigate blood glucose levels in healthy subjects and patients with DM as well as healthy individuals and determine if there is any association between higher oral glucose concentrations with oral manifestations, such as tooth cavities, periodontal diseases, candidiasis, lichenoid reaction and xerostomia.

Methods

The subjects consisted of 260 individuals in two separate groups. The first group consisted of 128 patients suffering from DM, referring to the Diabetes Clinic of Bahonar Hospital for routine check-ups. The second group (132 persons) were selected from those who referred to two laboratory centers in Kerman, Iran (Razi Laboratory and Besat Clinical Laboratory) for their annual medical check-ups with no history of DM.

Subjects with no history of smoking, a minimum age of 20, and 8 h of fasting before collecting their blood and salivary samples were selected for the study. We also made sure that the healthy group with fasting blood sugar (FBS) lower than 100 mg/dl had no systemic diseases and did not take medications influencing either the secretion or the glucose level of the saliva.[4] All the volunteers were asked to clean their teeth and mouth at least 90 min before sampling and were also asked to present themselves for sampling at 7:30-9 am.

The criteria for diagnosis of DM in the first group consisted of:

Glycated hemoglobin (HbA_1C) equal or greater than 6.5%; fasting plasma glucose ≥ 126 mg/dl; 2 h plasma glucose ≥ 200 mg/dl or in patients with the classic symptoms of hyperglycemia and crisis hyperglycemia and one accidental plasma glucose ≥ 200 mg/dl.[8]

After the objectives and procedures had been explained, the subjects signed informed consent forms. A trained post graduate student completed an information checklist containing age, gender, type of diabetes and the last medical examinations including FBS and HbA_1C. The oral mucosa was examined for any oral abnormalities, including ulcers, white and red plaques, lichenoid reaction, hyperplastic candidiasis, erythematous candidiasis, thrush, angular cheilitis, denture stomatitis, and median rhomboid glossitis[9] and the characteristics of the lesions and their location.

In order to check the condition of the teeth in terms of the presence of cavities, the World Health Organization guidelines were used to calculate index of the sum of decayed teeth, absent teeth due to decayed missing filled teeth (DMFT).[10] Tissues supporting the teeth were examined with the aid of periodontal disease index (PDI) and 6 specific teeth, namely central and upper left first premolar, upper right first molar, lower left first molar and central and lower right first premolar were examined.[11] Xerostomia was evaluated based on Fox questionnaire.[12] In the present study, all the individuals were asked about any complaint of mouth soreness.

Unstimulated salivary samples were collected by the spitting method.[3] The patients were asked, after some rest, to keep their mouth closed and not swallow their

saliva for a few minutes; then they held their head above the saliva collecting container and poured their saliva (1-2 ml) into it. The sampling container was frozen at -20 °C and sent to the laboratory (3). The saliva glucose concentration was measured by glucose oxidase enzyme method using a special kit (Pars Azmun Co., Tehran, Iran) and an autoanalyzer machine (Tecknicon Co., RA-1000, USA).

This analytical and cross-sectional study was approved by the Ethics Committee (KA/90-521) of Kerman University of Medical Sciences. Data were analyzed using independent t-test and Pearson correlation test.

Results

A total of 260 individuals, including DM patients (35 males and 93 females) and healthy individuals (51 males and 81 females), were examined. Age of the participants ranged between 20 and 83 with an average of 47.06 years. There was no significant difference in salivary glucose between the two groups in terms of age but salivary glucose concentration in healthy males was significantly higher than that in females (Table 1).

Diabetic patients whose HbA_1C results were available had higher salivary glucose concentration ($P < 0.001$) (Table 1). The means of salivary glucose concentrations in the healthy and diabetic groups were 8.98 (± 0.76) and 10.05 (± 0.84) mg/dl, respectively, with no significant difference between the two groups ($P = 0.310$) (Table 1).

In healthy individuals no significant association was found between FBS and salivary glucose concentration ($P = 0.420$, $r = 0.07$), in contrast to the diabetics group in which there was a significant association between blood and salivary glucose concentrations ($P = 0.040$, $r = 0.70$). There was a significant association between HbA_1C and salivary glucose concentration ($P < 0.001$, $r = 0.62$) (Table 1).

In this study, there were significantly higher DMFT (10.95 vs. 7.25) and PDI (3.53 vs. 2.57) in DM patients compared to healthy individuals ($P < 0.001$). In addition, there was a significant association between high salivary glucose concentration and higher DMFT and PDI, irrespective of the presence of DM ($P < 0.001$) (Table 1). The prevalence of oral manifestations in the two healthy and diabetics groups as shown in table 2.

Two individuals from the healthy group and thirty patients from the diabetics group

Table 1. The correlation coefficient and P value between saliva glucose concentration and age, HbA_1C, FBS, DMFT and PDI

Salivary glucose	P, r				
	Age	HbA_1C	FBS	DMFT	PDI
Normal	0.870, -0.01	-	0.420, 0.07	*0.001, 0.47	*0.001, 0.32
Diabetic	0.300, 0.09	*0.001, 0.62	*0.040, 0.17	*0.001, 0.79	*0.004, 0.31
Total	0.250, 0.07	-	*0.020, 0.14	*0.001, 0.74	*0.001, 0.31

*P < 0.050 statistically significant

FBS: Fasting blood sugar; DMFT: Decayed missing filled teeth; PDI: Periodontal disease index

Table 2. The frequencies of oral manifestations in the two groups, healthy and diabetics

Lesion	Healthy group [n (%)]	Diabetic group [n (%)]	P
Candidiasis	6 (4.5)	23 (17.6)	0.001*
Lichenoid reaction	2 (1.5)	2 (1.5)	0.990
Frequent abscess	0 (0.0)	8 (6.2)	0.002*
Tongue blade sign	3 (2.3)	39 (30.4)	< 0.001*
Xerostomia	3 (2.3)	46 (35.9)	< 0.001*

*P < 0.050 statistically significant

Table 3. Comparing the salivary glucose concentration in those with and without oral manifestation, classified by diabetes status

Oral manifestations	Total		Diabetic group		Healthy group	
	Mean of saliva Glucose (mg/dl) (SE)	P	Mean of saliva Glucose (mg/dl) (SE)	P	Mean of saliva Glucose (mg/dl) (SE)	P
Candida erythematous						
Yes	2 (0.00)	0.430	10.67 (5.23)	0.900	8.5 (4.29)	0.830
No	8.9 (0.76)		10.03 (0.85)		9.48 (5.70)	
Thrush						
Yes	3.5 (1.50)	0.380	10.67 (5.23)	0.520	10.25 (2.87)	0.800
No	8.9 (0.77)		10.03 (0.85)		9.44 (0.57)	
Median rhomboid glossitis						
Yes	-	-	12 (4.04)	0.720	12 (4.40)	0.630
No	8.89 (0.76)		10 (0.85)		9.43 (0.57)	
Denture stomatitis						
Yes	2.5 (0.50)	0.300	8.53 (1.88)	0.510	7.82 (1.72)	0.550
No	8.9 (0.77)		10.25 (0.92)		9.58 (0.59)	
Angular cheilitis						
Yes	4 (2.00)	0.420	13.75 (4.85)	0.440	11.8 (4.05)	0.560
No	8.9 (0.77)		9.2 (0.84)		9.37 (0.56)	
Lichenoid reaction						
Yes	8 (0.01)	0.240	5 (3.00)	0.450	6.5 (1.50)	0.130
No	8.9 (0.77)		10.3 (0.85)		9.51 (0.57)	
Frequent abscess						
Yes	-	-	14.63 (4.1)	0.160	14.63 (4.10)	0.100
No	8.89 (0.76)		9.74 (0.83)		9.3 (0.57)	
Tongue blade sign						
Yes	16.67 (6.17)	0.120	11.21 (1.50)	0.360	11.6 (1.41)	0.090*
No	8.71 (0.76)		9.54 (1.01)		9.05 (0.61)	
Xerostomia (Fox)						
Yes	16.67 (6.17)	0.120	11.04 (1.42)	0.370	11.39 (1.38)	0.100
No	8.71 (0.76)		9.49 (1.04)		9.01 (0.60)	

*P < 0.050 statistically significant; SE: Standard error

suffered from burning mouth syndrome. Oral examinations of all these subjects confirmed the presence of local factors, including Candida infection and xerostomia. There was no significant association between salivary glucose concentration and oral manifestations in healthy and diabetic groups (P > 0.050) (Table 3). Overall, there was no significant association between salivary glucose level and oral manifestations in all the participants (P > 0.050) (Table 3).

Discussion

Nowadays, many studies are trying to use saliva in diagnosis or even monitoring the level of control of the diseases. Saliva is a complex fluid that is produced in salivary glands and can take some substances from the blood. Possibly, saliva component changes show some systemic diseases or cause changes on oral mucosa surface. Since Jurysta et al. reported no differences in glucose concentrations of in stimulated and non-stimulated salivary flow in normal and diabetic individuals, in present study unstimulated saliva was used.[3]

The present study showed that higher salivary glucose level is associated with higher DMFT and PDI, regardless of the individuals' health status. In addition, the present study showed no significant difference between high salivary glucose concentration and oral manifestations such as ulcers and Candida infections. One of the findings of the present study was higher salivary glucose concentrations in male

healthy patients compared to the female healthy ones, but there was no significant difference between two genders in diabetics group which the latter agrees with the findings of Panchbhai et al.[13]

This study showed that the concentration of salivary glucose in diabetic patients was not significantly higher than that in healthy individuals (P > 0.050), consistent with the results of two previous studies [1,14] and in contrast with those of some other studies.[3,15,16] These differences of analysis results might be due to different methods of measurement of salivary glucose or collecting the samples. In addition, the level of maintaining oral hygiene and plaque on teeth can influence on salivary glucose. In this study, blood glucose did not show any significant association with salivary glucose in non-diabetic patients (P > 0.050). Previous studies have shown the same results.[4,17] However, in diabetic patients this association was weakly significant, consistent with some previous studies.[5-7,13,18,19]

In the present study, diabetic patients with high HbA1C had higher salivary glucose concentrations (P < 0.001). This correlation was found in a study by Reuterving et al.[18] but was in contrast with the results reported by Darwazeh et al.[19] However, the previous studies had conflict on this matter.

In the present study, there was a significant association between salivary glucose and DMFT and PDI indices in normal and diabetic patients. One may argue that oral hygiene has an influence on oral indices, and we could not evaluate the quality of oral cleanliness in the subjects, but this is one of the limitations of the present study. However, the PDI and DMFT indices were significantly higher in diabetic patients in the present study (P < 0.001). Bakianian et al.[1] and Lopez et al.[5] have reported similar results.

The increasing rate of dental caries and periodontal problems in diabetic patients can be due to xerostomia, saliva protection impairment related immune system, acidogenic microorganisms and poor oral hygiene and plaque accumulation.[1]

In the present study, there was no significant relationship between the concentration of salivary glucose and Candida infection in diabetic and non-diabetic individuals (P > 0.050), consistent with previous studies.[20,21] However, these studies showed that high carrier state of Candida does not result in oral candidiasis and glucose concentration cannot predict the prevalence of such infections.[20,21] The present study did not show any significant association between salivary glucose and oral manifestations in DM and non-DM patients (P > 0.050). Therefore, it can be assumed that other factors such as microvascular deterioration, immune system response and infection mediators influence oral manifestations in diabetic patients.[22]

This study had several limitations. For instance, we could not gather HbA_1C data in all the diabetic patients; in addition, we could not match the participants based on gender and age and we were unable to control oral hygiene before sampling. We hope this preliminary study can pave the way for better designed research studies.

Conclusion

The present study showed that the salivary glucose concentration had a positive association with DMFT and PDI in diabetic and non-diabetic patients. In this study, we found an association between salivary and blood glucose in diabetic patients.

Conflict of Interests

Authors have no conflict of interest.

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