Original Article

Salivary glucose levels in diabetes mellitus patients: A case–control study

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Abstract

Aim: The aim of the present study was undertaken to correlate the glucose levels in saliva and blood of diabetic and healthy nondiabetic individuals and to determine the efficacy of saliva as a diagnostic tool.

Setting and Design: This was a case–control study.

Materials and Methods: Forty-five patients previously diagnosed with diabetes mellitus and 45 healthy controls were included in the study. The patients and controls were asked to come to the clinic in the morning, after 8–10 h fasting. At that time, 5 ml of venous blood and unstimulated saliva was collected from both the groups, and 2 h after meal, again, venous blood and unstimulated saliva were collected. The saliva and sera from blood samples were subjected to glucose estimation. Saliva was collected in sterilized vials, and blood was collected in test tubes. Glucose estimation was done by oxidase–peroxidase method.

Statistical Analysis: Pearson's correlation coefficient, Student's *t*-test and paired *t*-test were used for statistical analysis.

Results: Correlation coefficient values show that there is a significant positive correlation between fasting blood and fasting salivary glucose levels and postprandial blood and postprandial salivary glucose levels.

Conclusion: Salivary glucose level estimation can be used as a potential indicator in screening, diagnosis and monitoring of diabetes mellitus. Furthermore, it is an easy and noninvasive method.

Keywords: Blood glucose levels, diabetes mellitus, salivary glucose levels

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INTRODUCTION

Diabetes mellitus is a disorder of carbohydrate metabolism characterized with hyperglycemia and glycosuria. Diabetes mellitus affecting approximately 8.4% of adults aged 18–99 years in 2017 and predicted to rise to 9.9% in 2045.[1] Monitoring blood glucose at frequent intervals causes unnecessary discomfort and mental trauma to patients; therefore, a much simpler and noninvasive technique for the diagnosis and monitoring of diabetes is very desirable.[2] These days, interest has been increasing for the use of saliva as a diagnostic fluid.[3]

The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction of different organs and impaired salivary gland functions leading to changes in saliva composition.[4]

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The present study is aimed to find an alternative medium for the diagnosis and monitoring of diabetes comparing fasting and postprandial serum glucose levels with salivary glucose levels.

The purpose of this study is to compare fasting and postprandial serum and salivary glucose levels and to determine the efficacy of saliva as a diagnostic tool.

MATERIALS AND METHODS

All the individuals were the ones who visited the Oral Medicine Department of Maharaja Ganga Singh Dental College and Research Centre, Sri Ganganagar (Rajasthan). The samples were obtained from individuals who volunteered to participate in this study.

Total participants are 90 (45 healthy individuals and 45 diabetic patients who are previously diagnosed with diabetes mellitus) in the age group of 25–70 years. Blood and salivary samples were collected from these individuals during resting condition.

The patients and controls were asked to come to the clinic in the morning, after 8–10 h fasting. At that time, 5 ml of venous blood and unstimulated saliva was collected from both the groups. Two hours after meal, again, venous blood and unstimulated saliva were collected. Saliva was collected by the method of spitting the saliva, and blood was collected by venipuncture technique.

All the participants were asked to wash their mouth thoroughly with water before collecting fasting and postprandial salivary samples. The participants were asked to swallow the saliva present in the mouth and then to remain still without moving the tongue for 1 min. The participants were asked to spit the saliva into clean sterilized vials once in every 60 s for a total of 5 min.

After collecting both salivary and blood samples (fasting and postprandial), samples were subjected for glucose estimation. Blood glucose levels and salivary glucose levels are determined using oxidase–peroxidase method.

Statistical analysis

Mean and standard deviation of fasting and postprandial serum glucose and salivary glucose were calculated for both diabetic patients and controls.

These were then compared using Pearson's correlation coefficient, Student's *t*-test and paired *t*-test. $P < 0.05$ was considered statistically significant.

RESULTS

In our study, the control group showed fasting serum glucose levels and fasting salivary glucose levels [Table 1].

The postprandial serum glucose levels and postprandial salivary glucose levels are shown in Table 1.

In the diabetic group, the fasting serum glucose levels and fasting salivary glucose levels are shown in Table 2.

The postprandial serum glucose levels and postprandial salivary glucose levels are shown in Table 2.

Correlation coefficient values show that there is a significant positive correlation between fasting blood and fasting salivary glucose levels and postprandial blood and postprandial salivary glucose levels [Tables 3 and 4].

Table 1: Mean and standard deviation of blood glucose and salivary glucose for healthy group

	Fasting blood healthy	PP blood healthy	Fasting salivary sugar healthy	PP salivary sugar healthy
n				
Valid	45	45	45	45
Missing	0	0	0	0
Mean	74.71	106.27	0.1818	0.2287
SD	10.350	7.250	0.06756	0.04475
Sum	3362	4782	8.18	10.29

n: Number of total patients, Valid: Valid number of patients, Missing: Missing patients, SD: Standard deviation, PP: Postprandial

Table 2: Mean and standard deviation of blood glucose and salivary glucose for diabetic group

	Fasting blood diabetes	PP blood diabetes	Fasting salivary sugar diabetes	PP salivary sugar diabetes
n				
Valid	45	45	45	45
Missing	0	0	0	0
Mean	194.53	291.27	1.0024	2.3122
SD	39.002	70.996	1.00679	2.42810
Sum	8754	13107	45.11	104.05

n: Number of total patients, Valid: Valid number of patients, Missing: Missing patients, SD: Standard deviation, PP: Postprandial

Table 3: Pearson's correlation coefficient for diabetic group

	Fasting salivary sugar diabetes	Fasting blood diabetes
Fasting salivary sugar glucose		
Pearson correlation	1	0.651**
Significant (two-tailed)		0.000
n	45	45
Fasting blood glucose		
Pearson correlation	0.651**	1
Significant (two-tailed)	0.000	
n	45	45

n: Number of patient. **=Correlation is significant at the 0.01 level (2 - tailed)

We also compared fasting blood and fasting salivary glucose levels and postprandial blood and postprandial salivary glucose levels according to gender also, which signifies that gender does not play any role in the occurrence of diabetes mellitus [Table 5].

Graphs 1 and 2 show a positive correlation between fasting serum and salivary levels and between postprandial serum and salivary levels, which represent that if serum levels increase, then salivary levels also arise.

A comparison between fasting blood glucose and fasting salivary glucose levels is shown in Graph 1

Table 4: Pearson's correlation coefficient for diabetic group

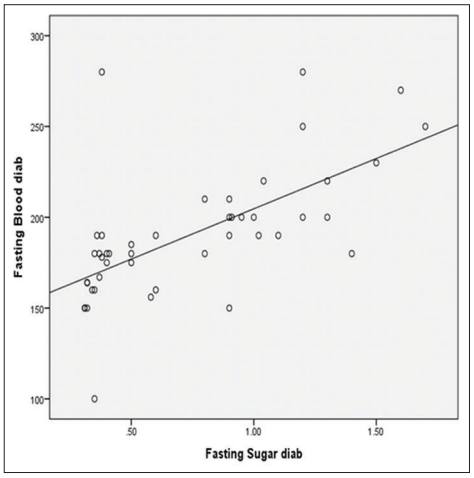
	PP blood diabetes	PP salivary sugar diabetes
PP blood glucose		
Pearson correlation	1	0.299*
Significant (two-tailed)		0.046
n	45	45
PP salivary glucose		
Pearson correlation	0.299*	1
Significant (two-tailed)	0.046	
n	45	45

**n*: Number of patient, PP: Postprandial

Table 5: Comparison of glucose parameters in diabetic group by gender (Student's *t*-test)

	Sex	Mean	SD	*P*
Fasting blood glucose	Male	194.00	40.149	0.93
	Female	195.04	38.770	
Fasting salivary glucose	Male	0.9559	0.89426	0.76
	Female	1.0470	1.12235	
PP blood glucose	Male	293.73	75.372	0.82
	Female	288.91	68.164	
PP salivary glucose	Male	2.1527	2.26037	0.56
	Female	2.5787	2.60861	

PP: Postprandial, SD: Standard deviation



Graph 1: The comparison between fasting blood glucose levels and fasting salivary glucose levels, which represents the increase in fasting blood glucose levels along with fasting salivary glucose levels

A comparison between postprandial blood glucose levels and postprandial salivary glucose levels is shown in Graph 2.

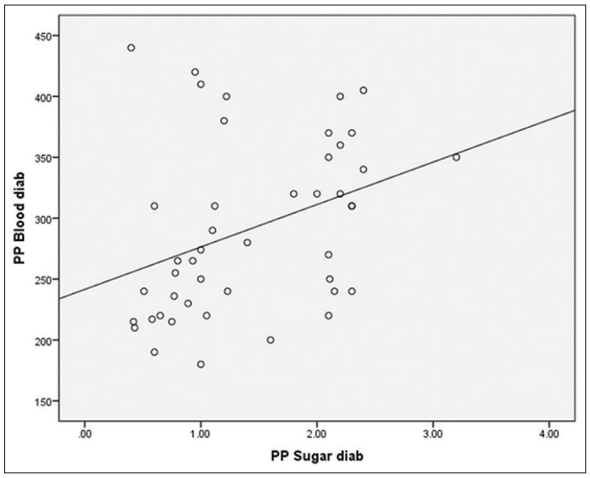
DISCUSSION

Diabetes mellitus, a disorder of carbohydrate metabolism, possess a challenge to health professionals. In individuals with a history of diabetes, oral health problems are usually related to metabolic control of the disease and poorly controlled glucose levels tend to have adverse effect on salivary glands.

The technique usually involved in estimation of the glucose levels is by venepuncture technique, which is traumatic, especially in children leading to anxiety and trauma.[5] Hence, the need for an alternative technique arises.

These days, interest has been increased in the use of saliva as a diagnostic fluid because all steroids of diagnostic significance, antibodies, hormones, certain drugs, etc., which are present in the saliva can easily and accurately be measured. Another advantage of saliva is that it is an organic fluid and can be collected easily and can be easily preserved.[6] Unstimulated saliva has been used because of the possibility of dilution and modulation of PH in stimulated saliva.[7]

Glucose is a small molecule that can readily diffuse through the semipermeable membrane and hence can be detected in saliva, especially when the blood sugar levels are elevated. Other explanations given for the presence of glucose in saliva are diabetic membranopathy. According to Harrison and Bowen, any alteration in the basement membrane of



Graph 2: The comparison between postprandial blood glucose levels and postprandial salivary glucose levels, which represents the increase in postprandial blood glucose levels along with postprandial salivary glucose levels

blood vessels may cause increased transport of glucose into saliva.[6,8]

We know that glucose is present in the saliva of normal individuals; however, the mechanism of its secretion is still obscure. Both paracellular and intercellular pathways have been proposed,[9] but this is still a hypothesis rather than an established theory. López *et al.*[7] tried to show that the salivary glands act as filters of blood glucose that are altered by hormonal or neural regulation. According to Quershi *et al.*,[10] persistent hyperglycemia leads to microvascular changes in the blood vessels, as well as basement membrane alteration in salivary glands. This leads to increased leakage of glucose from the ductal cells of the salivary gland, thereby increasing the glucose content in saliva. Sreedevi *et al.*[11] quoting the works of Harrison commented that glucose is a small molecule that easily diffuses through semipermeable membranes.

It is well established that the complications of diabetes are due to microvascular changes.[12] Many theories have been put forth to explain the microvascular alterations. To summarize, hyperglycemia leads to increased advanced glycosylation end products, commonly known as "Advanced Glycosylation end products (AGEs)." These AGEs cross-link proteins such as collagen and extracellular matrix proteins, leading to basement membrane alteration and hence endothelial dysfunction. This alters the microvasculature structure and makes it more permeable.

Belazi *et al.*[13] proposed that the increased permeability of basement membrane in insulin-dependent diabetes mellitus may lead to enhanced leakage of serum-derived components into whole saliva through gingival crevice. The small glucose molecule can easily diffuse through the semipermeable basement membrane. They blamed the gingival crevicular fluid as the culprit for increased glucose levels in salivary secretion. This shows that the presence of glucose in saliva is multifactorial and no single mechanism can be blamed.

Similar to our study, five studies[11,13-16] found a positive correlation between salivary glucose and serum glucose. However, in contrast to our study, three other trials[17-19] could not establish a correlation between salivary and serum glucose. Even Englander *et al.*[20] expressed doubt regarding the replacement of plasma with parotid secretion in the diagnosis of diabetes mellitus because of its lower levels of glucose concentration.

In our study, we divided the patients into two groups: controls and cases. We found a statistically significant difference among the two groups, and the salivary glucose levels were found to increase as serum glucose levels increased. We found that patients with serum glucose levels between 100 and 280 mg/dl showed a mean salivary glucose level of 1.002 mg/dl and patients with serum glucose levels between 180 and 440 mg/dl reflected a mean salivary glucose level of 2.31 mg/dl. As such, we are tempted to say that patients with salivary glucose above 1.002 mg/dl have a very high chance of having serum glucose levels above 100 mg/dl.

We also compared blood and salivary glucose levels in accordance with gender also, which signifies that gender does not play any role in the occurrence of diabetes mellitus. Limitation of the study is that it has a small sample size and composition of saliva changes in different conditions leading to alteration in salivary glucose level.[21] Another limitation is inconsistent levels of salivary glucose because of the following reasons:[21]

1. In psychological and physical stress, there is an increase in salivary amylase level leading to increase in the breakdown of starch to glucose
2. In mucous type of saliva, there is an increase in mucous content (mucopolysaccharide and glycoproteins)
3. Antimicrobial activity increases salivary hydrogen peroxidase which leads to overestimation by oxidase–peroxidase method.

Nevertheless, further studies with a larger sample size are needed to evaluate the diagnostic value of salivary glucose levels in the early diagnosis of diabetes mellitus.

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Conflict of interest
There are no conflicts of interest.

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