

Salivary Glucose Level and its Correlation With Blood Glucose Level in Patients with Diabetes Mellitus-an in-Vivo Study

Afreen Nadaf¹, Zhahid Hassan², Summiya Farooq³

ABSTRACT

Introduction: Diabetes mellitus is a globally widespread metabolic disease caused due to hyperglycemia, which is the result of defect in insulin secretion, insulin action, or both. The aim of the study was to assess the correlation of fasting blood glucose level (FBG) and fasting salivary glucose level (FSG) in diabetic and non-diabetic patients.

Material and methods: An experimental study was conducted in 60 patients who fulfilled the selection criteria. Patients were categorized into 2 groups -30 patients with diabetes mellitus (Group A) and 30 healthy non-diabetic patients (Group B). The fasting blood and unstimulated saliva samples were collected from the patients. These samples were then subjected for analysis of glucose in blood and saliva using HEXOKINASE reagent in Abbot C4000 Automatic analyzer and the results were recorded.

Results: A statistically significant difference ($p=0.0001^*$) was found between the fasting blood glucose level between the 2 groups with mean FBG level in group A (182.23 ± 12.67) and fasting blood glucose level among group B was 73.59 ± 7.56 . The mean FSG was higher in diabetic group (13.13 ± 3.2) than in non-diabetic group (0.72 ± 0.08). A highly statistically significant correlation was found between fasting salivary glucose and fasting blood glucose in both the groups.

Conclusion: The present study clearly depicts that fasting salivary glucose is increased in diabetics and this finding was statistically significant. On the basis of the findings, it was concluded that salivary glucose levels could serve as a potentially noninvasive adjunct to monitor glycemic control in diabetic patients

Keywords: Blood Glucose, Diabetes Mellitus, Fasting Glucose, Salivary Glucose

INTRODUCTION

Diabetes mellitus (DM) is one of the oldest diseases known to humankind. Egyptian manuscript reported it for the first time about 3000 years ago.¹ It is a complex multisystem non-communicable disease with a rising prevalence worldwide with potentially devastating complications that affects all age groups leading to death and disability.² The International Diabetes Federation estimates 382 million people worldwide had diabetes in 2013, and the number is forecasted to reach 592 million by 2035 (a 55% increase). There were 5.1 million diabetes-related deaths globally in 2013, equaling to one death every 6 secs, an 11% increase over 2011.³⁻⁵ India has world's largest diabetes population with 50.8 million people suffering from diabetes followed by China. In 2025, approximately 57.2 million diabetics will be noticed in India.^{6,7}

Diabetes mellitus is a complex multisystemic metabolic disorder characterized by a relative or absolute deficiency

of insulin secretion and/or concomitant resistance to the metabolic action of insulin on target tissues.⁸ Altered salivary composition and function have been reported in diabetes mellitus. Oral physicians are liable to come in contact with significant number of patients with diabetes mellitus owing to the plethora of oral manifestations that are seen in diabetes mellitus. Certain oral lesions are commonly seen in patients with diabetes mellitus such as a higher incidence of caries, periodontal disease and candidiasis.^{9,10}

To minimize the risk of complications associated with this disease, it is necessary to regularly monitor the blood glucose levels of diabetic patients. Various bio fluids that are used to monitor glucose levels include blood and urine.² Invasive tests are generally disliked because of pain and inconvenience caused by finger pricking and is a major problem for young children and results in negative consequences for disease management.

Since 2002, The National Institute of Dental and Craniofacial Research created opportunities to overcome these limitations by investigating oral fluids as a diagnostic tool for the assessment of health and disease status. Saliva, commonly considered as the 'mirror of the body', is very attractive as a biomedium for clinical diagnostics. Its unique properties, such as noninvasive accessibility and the presence of plentiful disease biomarkers, make it particularly attractive for disease diagnosis and monitoring.^{5,11,12} Several studies have shown that salivary glucose levels can be used as an important non-invasive indicator of the blood glucose levels.^{9,10-14} Hence, the present study was aimed to assess the correlation of fasting blood glucose level (FBG) and fasting salivary glucose level in diabetic mellitus and non-diabetic mellitus patients.

MATERIAL AND METHODS

The study was conducted on individuals with ages ranging from 20 to 75 years referred from Jawaharlal Nehru Memorial Hospital, Srinagar and private practitioner (Endocrinologist).

¹Tutor, Department of Oral Pathology, Government Dental College and Hospital, ²Consultant, Department of Endocrinology, ³Medical officer, Department of Pathology, Jawaharlal Nehru Memorial Hospital, Srinagar

Corresponding author: Afreen Nadaf, MDS, Tutor, Department Of Oral Pathology, Government Dental College and Hospital, Srinagar

How to cite this article: Afreen Nadaf, Zhahid Hassan, Summiya Farooq. Salivary glucose level and its correlation with blood glucose level in patients with diabetes mellitus-an in-vivo study. International Journal of Contemporary Medical Research 2017;4(12):17-20.

The study comprised 60 patients and were categorized into 2 groups, each consisting of 30 patients with diabetes mellitus (Group A) and 30 healthy non-diabetic patients (Group B). Diagnosis of diabetes was confirmed according to the criterion laid out by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus.¹³ Written informed consent was obtained from the patient before the start of study after explaining the purpose and the procedures involved in the study

Inclusion criteria

1. Patients diagnosed with DM in age range 20–75 years
2. Age- and gender-matched healthy individuals.

Exclusion criteria

1. Patients having any other systemic diseases and on regular medication for the same
2. Pregnant women, mentally compromised, radiotherapy for head and neck cancer, oral mucosal, or salivary gland disorders, antibiotic or corticosteroid therapy for preceding 3 months
3. Patients with habits of tobacco or alcohol and smoking were excluded from the study.
4. Uncooperative patients.

Collection and Analysis of Samples

Saliva sample collection: The unstimulated whole saliva was used for the estimation of salivary glucose. The subject was asked first to rinse his or her mouth thoroughly with water. Each subject was instructed to sit straight in a comfortable position in a calm isolated room and not to swallow saliva for 5 minutes and then expectorate intraoral retained saliva into a sterile container placed. 2 ml of collected saliva was used in the study.

Groups	Mean±SD	p
Group A	182.23±12.67	0.0001*
Group B	73.59±7.56	
Group A = Diabetics Group B = healthy, SD: Standard deviation; Unpaired t test; *Statistically significant at p< 0.05		
Table-1: Comparison of mean Fasting Blood Glucose level among both groups		

Groups	Mean±SD	p
Group A	6.13± 3.2	0.0001*
Group B	0.72±0.08	
Group A= Diabetics Group B= healthy, SD: Standard deviation; Unpaired t test; * Statistically significant at p< 0.05		
Table-2: Comparison of mean Fasting Salivary glucose level among both groups		

Groups	Fasting Blood Glucose level		
	Group A (n=30)	Fasting Salivary glucose level	Correlation coefficient (r)
p value			p =0.0001**
Group B (n=30)	Fasting Salivary glucose level	Correlation coefficient (r)	0.789
		p value	p= 0.001**
Pearson's Correlation test **Correlation is significant at the 0.01 level; FSG: Fasting saliva glucose, FBG: Fasting Blood Glucose; Group A= Diabetics Group B= healthy			
Table-3: Correlation between FBG and FSG for Group A and Group B			

Blood sample collection: Under aseptic conditions using a sterile disposable 25 gauge needle, 2ml of intravenous blood was collected from the antecubital vein. An anticoagulant (sodium fluoride) was added to test tube containing blood. Saliva and blood samples were collected from the patients after 8 h of fasting and samples were processed from Govt Medical College, Srinagar.

Salivary glucose and blood glucose estimation: Each unstimulated saliva sample and blood sample were centrifuged at 4000 rpm for 5 min. Clear supernatants were processed immediately for estimation of glucose. Glucose was analyzed by HEXOKINASE reagent. Automatic analyzer/ Abbot C4000 was used for the estimation of glucose and readings were noted for both.

STATISTICAL ANALYSIS

The data obtained was compiled systematically in Microsoft Excel sheet and was subjected to statistical analysis by using SPSS software (Statistical package for social sciences software 17). Unpaired t test was used to compare the mean fasting blood glucose level and fasting salivary glucose level between the groups and correlation was assessed using Pearson's correlation test.

RESULTS

A total of 60 subjects who fulfilled the eligibility criteria were enrolled in 2 groups, Group A= Diabetics, Group B= healthy. The mean fasting blood glucose level among group A was 182.23±12.67. The mean fasting blood glucose level among group B was 73.59±7.56. A statistically significant difference was seen between the groups (p=0.0001*) (Table 1).

A statistically significant difference (p=0.0001*) was found between the fasting salivary glucose (FSG) level between the 2 groups with mean FSG level in group A (13.13± 3.2) and mean FSG level in Group B was 0.72±0.08 (Table 2). Correlation between FBG and FSG for Group A and Group B showed a very high significant difference (p= 0.001*).

DISCUSSION

The most recognized types of diabetes are type 1 (IDDM) and type 2 (NIDDM). The other types of diabetes are gestational diabetes, secondary diabetes, and maturity-onset diabetes of the young.¹⁵ Chronic hyperglycemia may lead to metabolic dysregulation and failure of various organs, especially eyes, kidneys, nerves, heart, and blood vessels.¹⁴ However, blood collection is an invasive procedure and is more costly as it requires the help of a trained technician and the use of sharps.

Thus a need arises to establish non-invasive technique to monitor glyceemic control.¹⁶

Saliva is a wonderful adjunct and has a great role in the homeostasis of the oral cavity because it stabilizes the ecosystem of the oral cavity and hence, it serves as a brilliant marker for early detection of many diseases.^{17,18} Of all salivary parameters, salivary glucose, appears to be most closely related to the oral environment in patients with diabetes. Glucose, a small molecule can easily diffuse through semipermeable membranes thus increasing the salivary glucose levels, which ultimately results in consequent loss of homeostasis and greater susceptibility to diseases in the oral cavity. Normal glucose levels in saliva are 0.5–1.00 mg/100 ml and do not considerably have an effect on oral health or support the growth of microorganisms. Biochemistry reveals that the normal value of salivary glucose in a healthy nondiabetic individual is <2 mg/dl.² There is lack of consensus among different authors on the utility of saliva for monitoring glyceemic control. Thus the aim of the present study was to assess the correlation of fasting blood glucose level (FBG) and fasting salivary glucose level in diabetic and non-diabetic mellitus patients.

In the present study, glucose concentration in unstimulated whole saliva was analysed. Unstimulated whole saliva has been used in the majority of diagnostic studies because stimulated whole saliva is less suitable for diagnostic applications as the foreign substances used to stimulate saliva tend to modulate the fluid pH and generally stimulate the water phase of saliva secretion, resulting in a dilution in the concentration of molecules of interest.¹⁸

For Diabetic group (Group A), the mean FSG was 6.13 ± 3.2 mg/dl, and the mean FBG was 182.23 ± 12.67 mg/dl. Pearson's correlation test showed significant correlation at 0.01 level. The present study results are in accordance with the following studies. The study by Abikshyeet et al. revealed the mean FSG as 4.22 ± 3.59 mg/dl for diabetic group¹⁴ and Panchbhai et al. in 2010, recorded a mean FSG of 7.64 ± 6.44 mg/dl.¹⁹ Panchbhai again did a study in 2012 and found FBG as 6.83 mmol/dl.¹⁰ Another study conducted by Ravindran et al. observed mean of FSG as 6.567 ± 3.04 mg/dl for the diabetic group.²⁰ The study by Hegde et al. revealed mean SGL as 10.46 ± 6.50 mg/dl for diabetic group.²¹ Literature review showed that many studies conducted in this regard contradict our study results. Bowen conducted a study and recorded the SGL as 11.0 ± 2 µg/ml for good controlled DM.²² As for the study by Lopez et al. the values recorded for diabetic group was 1.48 ± 2.15 mg/dl.²³

Healthy non diabetic group (Group B) in our study had a mean FSG Level of 0.72 ± 0.08 mg/dl, and the mean FBG level was 73.59 ± 7.56 . Pearson's correlation test showed very highly significant correlation at 0.01 level. Few studies that are documented had the values in accordance to our study. Harrison and Bowen did a study and recorded the SGL as 5.0 ± 1.0 µg/ml for healthy subjects.²² The study by Abikshyeet et al. revealed mean FSG as 1.23 ± 0.52 mg/dl and mean FBG as 86.82 ± 9.46 mg/dl for nondiabetic group.¹⁴ The study done by Hegde et al. recorded the salivary glucose for

healthy group was found to be 7.41 ± 3.44 mg/dl and study conducted by Agrawal et al. had 6.08 ± 1.16 mg/dl as mean FSG and FBG as 92.11 ± 9.39 mg/dl in nondiabetic group which is not in agreement with the results of our study.^{16,21}

CONCLUSION

Outcome of the present study clearly depicts that fasting salivary glucose is increased in diabetics and this finding was statistically significant. Thus it can be inferred that saliva can be used as an alternative to blood for diagnosing and monitoring diabetes mellitus status as it is noninvasive compared to other fluids and can be easily used in children, elderly, critically ill and debilitated patients. Oral diagnosticians are advised to screen the diabetic patients for any oral infections at the earliest and further institute the management for the same. However, further studies need to be undertaken involving larger sample size, using different methods of saliva and blood collection, by taking glycosylated hemoglobin to estimate blood glucose levels. The standardized procedure of salivary glucose estimation for DM may herald a new era in noninvasive method of diagnosis.

REFERENCES

- Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: A review of current trends. *Oman Med J* 2012;27:269-73.
- Gupta S, Sandhu SV, Bansal H, Sharma D. Comparison of salivary and serum glucose levels in diabetic patients. *J Diabetes Sci Technol*. 2015;9:91-6.
- L. Guariguata et al., IDF Diabetes Atlas, sixth ed., International Diabetes Federation, 2013.
- IDF Diabetes Atlas Group. Update of mortality attributable to diabetes for the IDF Diabetes Atlas: estimates for the year 2011. *Diabetes Res Clin Pract*. 2013;100:277-9.
- Du Y, Zhang W, Wang ML. An On-Chip Disposable Salivary Glucose Sensor for Diabetes Control. *J Diabetes Sci Technol*. 2016;10:1344-1352.
- Diabetes facts. In: IDF Diabetes Atlas. 2011 May. URL: <http://www.idf.org/diabetesatlas> as accessed on 23 November 9 PM
- Pendsey S. Gravity of problem. In: Practical management of diabetes. 2nd ed, New Delhi: Jaypee brothers; 2004.
- Kumar S, Padmashree S, Jayalekshmi R. Correlation of salivary glucose, blood glucose and oral candidal carriage in the saliva of type 2 diabetics: A case-control study. *Contemp Clin Dent*. 2014;5:312-7.
- Patel BJ, Dave B, Dave D, Karmakar P, Shah M, Sarvaiya B. Comparison and Correlation of Glucose Levels in Serum and Saliva of Both Diabetic and Non-diabetic Patients. *J Int Oral Health*. 2015;7:70-6.
- Panchbhai AS. Correlation of Salivary Glucose Level with Blood Glucose Level in Diabetes Mellitus. *Journal of Oral and Maxillofacial Research*. 2012;3:e3.
- Lamy E, Mau M. Saliva proteomics as an emerging, non-invasive tool to study livestock physiology, nutrition and diseases. *J Proteomics*. 2012;75:4251-8.
- Wong DT. Salivary diagnostics powered by

- nanotechnologies, proteomics and genomics. *J Am Dent Assoc.* 2006;137:313-21.
13. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care.* 1997;20:1183-97.
 14. Abikshyeet P, Ramesh V, Oza N. Glucose estimation in the salivary secretion of diabetes mellitus patients. *Diabetes MetabSyndrObes.* 2012;5:149-54.
 15. Kumar V, Abbans K, Nelson F. Robbins and Cotran Pathologic Basis of Disease, 7th ed. Philadelphia: Elsevier Saunders; 2005.
 16. Agrawal RP, Sharma N, Rathore MS, Gupta VB, Jain S, Agarwal V, et al. Noninvasive Method for Glucose Level Estimation by Saliva. *J Diabetes Metab* 2013;4:266.
 17. Akasapu A, Hegde U, Nitin P. Correlation of Blood Glucose Levels with Salivary Glucose Levels in Type 2 Diabetes Mellitus: A Comparative Study. *Current Trends in Biomedical Engineering and Biosciences.* 2017;6: 1-4.
 18. Gupta S, Nayak MT, Sunitha JD, Dawar G, Sinha N, Rallan NS. Correlation of salivary glucose level with blood glucose level in diabetes mellitus. *J Oral MaxillofacPathol* 2017;21:334-9.
 19. Panchbhai AS, Degwekar SS, Bhowte RR. Estimation of salivary glucose, salivary amylase, salivary total protein and salivary flow rate in diabetics in India. *J Oral Sci* 2010;52:359-68.
 20. Ravindran R, Gopinathan DM, Sukumaran S. Estimation of salivary glucose and glycogen content in exfoliated buccal mucosal cells of patients with type II diabetes mellitus. *J ClinDiagn Res* 2015;9:ZC89-93.
 21. Hegde A, Shenoy R, D'Mello P, Smitha A, Tintu A, Manjrekar P. Alternative markers of glycemic status in diabetes mellitus. *Biomed Res* 2010;21:252-6.
 22. Harrison R, Bowen WH. Flow rate and organic constituents of whole saliva in insulin dependent diabetic children and adolescents. *Pediatr Dent* 1987;9:287-91.
 23. Lopez ME, Colloca ME, Páez RG, Schallmach JN, Koss MA, Chervonagura A, et al. Salivary characteristics of diabetic children. *Braz Dent J* 2003;14:26-31.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 09-12-2017; **Accepted:** 25-12-2017; **Published:** 11-01-2018