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Research Article

# COMPARISON AND CORRELATION OF SERUM AND SALIVARY GLUCOSE VALUES IN TYPE-II DIABETIC PATIENTS

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## Abstract

Aim: The aim of this study was to compare and correlation between Fasting plasma glucose (FPG) and Fasting salivary glucose (FSG) levels in type II diabetes mellitus. Objective: Fasting plasma glucose (FPG) analysis is the most important method for detection and diagnosis of diabetes mellitus. Due to difficulty and problems of this method for determination of glycemia in diabetic patients, recently the use of Fasting Salivary Glucose as a simple and non-invasive method to evaluate FPG has come into significant consideration of specialists. Material and Methods: This was a cross-sectional study which was done on 60 diabetic patients (test group) and 60 non diabetic patients (control group) sex matched. After collection of saliva and blood samples, The FPG and FSG levels were measured by GOD-POD method. The statistical significance was calculated by't'-test and regression test for quantitative variables and Chi-square test for qualitative variables**.**Results: The average FSG in diabetic and non-diabetic groups were 15.158 mg/dl and 3.176 mg/dl, respectively and the average FPG in diabetic and non-diabetic groups were 152.70 mg/dl and 68.20 mg/dl. Also the correlation coefficients between FPG and FSG in diabetic and non-diabetic groups were 0.992 and 0.995 respectively (p-value=0.0001). Conclusion: This study showed that there is a significant relationship between FPG and FSG. Therefore, FSG levels can be used as a non invasive method to detect FPG levels in diabetes mellitus patients.

**KEYWORDS: Diabetes Mellitus, Blood, Saliva, Glucose.**

## INTRODUCTION

Diabetes mellitus represents one of the major chronic health problems faced by the society today. Diabetes mellitus is a metabolic disease characterized by dysregulation of carbohydrate, lipid and protein metabolism.[1] The primary feature of this disorder is elevation in blood glucose levels (hyperglycemia), resulting from either a defect in insulin secretion from the pancreas, a change in insulin action or both.[1] According to World Health Organization projected report the diabetes mellitus to rise globally from 171 million in 2000

to 366 million in 2030.[2] India shelters the most number of people with diabetes mellitus worldwide. From 31 million in the year 2000, the number of persons with diabetes mellitus in India would register a 2.5 fold increase over the next 30 years so as to reach an alarming level of estimated 80 million by the year 2030.[3] Epidemiological studies conducted in India, showed that not only the prevalence was high in urban India but it was also increasing.[4] Diabetes mellitus has been classified into type 1 DM, type 2 DM, other specific types and gestational DM according to American Diabetes Association.[4]

Type I DM previously referred to as insulin dependent (IDDM) is a juvenile-onset diabetes mellitus affecting 10 to 15 percent of all patients with DM it is caused by immunologically controlled autoimmune destruction of beta cells of the pancreas. Type I DM develops in childhood or in adolescent age and is characterized with an absolute lack of insulin.[5]

A more frequent DM is the type II, currently referred to as adult-onset diabetes and previously as non-insulin dependent diabetes mellitus (NIDDM). Its early state manifests as insulin resistance with inappropriate glucose tolerance.[5]

Clinical symptoms of diabetes include polyuria, polydipsia and polyphagia Hyperglycemia is the immediate metabolic consequence of DM but, ultimately, there is widespread multisystem damage.[5]

The uncontrolled Diabetes mellitus having wide range of complications like diabetic neuropathy, diabetic retinopathy, diabetic nephropathy, cardiovascular diseases, dyslipidemia, and sepsis.[6] Oral complication of uncontrolled Diabetes includes periodontal disease, oral candidiasis, tooth loss, and dental caries. Other complications included oral mucosal ulcers, taste impairment, halitosis, xerostomia and salivary gland hypofunction and burning mouth sensation.[6, 7]

An important aspect in glycemic control is to regularly monitor blood glucose levels. Current methods employed in monitoring require either a blood or a urine sample.[7] obtaining blood samples is painful and difficult for diabetics who may have to repeat the procedure several times. Urine samples have also been used for analysis; however patients often face problems of discomfort. The obtained results have known to depict many discrepancies.[7]

Saliva is a unique fluid, whose important role is to maintain the well-being of oral cavity saliva acts as the mirror of the body and hence, is a perfect medium to be explored for disease health & surveillance. As a diagnostic fluid, saliva offers distinctive advantages over serum. It can be collected non-invasively with modest training and without use of any sophisticated equipment. The chances of infection are lowered and disposal of associated wastes, poses a lesser health hazard.[8]

## AIM

The present study was undertaken to quantitatively estimate the amount of glucose present in the serum & saliva of the type II diabetic patients.

## MATERIALS AND METHODS

A total of 120 subjects of aged between 40-80 years old attending the Department of Oral Medicine and Radiology were included in the study. The complete demographic data, past medical history of all the study subjects were recorded and informed consent was obtained. The study involved 60 type II diabetics and 60 non-diabetics subjects.

Inclusion criteria for the study group consisted of patients having positive history of established diabetes type II less than 6 months. The FPG value ≥126mg/dl and positive cardinal signs including history of polyuria, polydipsia and polyphagia. The criteria for control group included no history of DM and FPG <126mg/dl.

Patients who are already taking treatment for diabetes mellitus for a period of more than 6 months, patients on medication for any systemic diseases other than hypertension was excluded from the study. Patients with Sjogren's syndrome, pregnancy, sever periodontitis, saliva decreasing drug usage, smoking, positive history of salivary gland surgery and history of chemotherapy or head and neck radiotherapy were excluded from the study.

## SAMPLE COLLECTION

Both the blood glucose and salivary glucose samples were collected after 08-10 hours following the fast.

### Collection of blood

Under aseptic conditions 2 ml of the patient's intra-venous blood was obtained from the median cephalic vein of the forearm: Then blood was transferred to the disposable test tube and solution was centrifuged at 3000 rpm for 8-10 min. Clay Adams centrifuge machine is used. The cellular fraction of blood settles at the bottom and serum fraction settles at the top of the disposable test tube. Now with the help of a micro-pipette 1 ml of the glucose reagent was taken in another test tube. Next 10µl of the supernatant of the centrifuged serum sample was added to the glucose reagent. The colour change of solution was noted and the optical density (OD) was measured in a photocolorimeter based on the principle of enzymatic colorimetry.

Collection of saliva

Unstimulated whole saliva from diabetic patients and control subjects was collected using the "Navazesh method".[9] It was ensured that all the patients rinsed their mouth thoroughly prior to sample collection. This was done to eliminate the chances of food residue providing a source of glucose. Also the samples collected were immediately subjected to analysis, to avoid deterioration of the sample due to incubation and also, to avoid enzymatic alteration of glucose in saliva. Unstimulated whole saliva was collected in sterile containers by asking the patient to expectorate into it gradually over a period of 5-6 minutes till approximately 1ml of saliva was collected. 1ml of saliva was taken into a disposable test tube and centrifuged at 2000 rpm for 2-3 min. Now using a micro-pipette 1 ml of the glucose reagent was taken in another test tube. Next 10µl of the supernatant of the centrifuged saliva sample was obtained and added to the glucose reagent. This was then kept in a temperature controlled water bath at 37°C for 10 minutes. The colour change of solution was noted and the optical density (OD) was measured in a photocolorimeter based on the principle of enzymatic colorimetry. FPG and FSG levels were measured by GOD-POD method (Enzymatic Span Diagnostics Glucose Test Kit INDIA).

## STATISTICAL ANALYSIS

Statistical analysis was done by Pearson correlation and Student't' test for the continuous variable (2-tailed) Fisher exact test or Chi-square test for categorical variables. The critical levels of significance of the results were considered at 0.05 levels i.e. ($P < 0.05$) was considered significant.

## RESULT

The study population comprised of 120 patients. There were 60 male and 60 females in the study. They were in the age ranging from 40 to 80 years. The mean age of diabetic patients was 57.10 ± 7.149 years. The mean age of the control group was 55.27 ±7.458 years.

The fasting plasma glucose (FPG) values in diabetics group was ranged from 130 to 186 mg/dl with an average of 152.70 ± 14.94 mg/dl. The fasting salivary glucose (FSG) values in diabetic group were ranged from 12.2 to 19.3 mg/dl with an average of 15.158 ± 1.7804 mg/dl. In the control group fasting plasma glucose (FPG) values ranged from 39 to 96 mg/dl with an average of 68.20 ± 14.631 mg/dl. The fasting salivary glucose (FSG) values in control group ranged from 1.12 to 6.62 mg/dl with an average of 3.176 ± 1.2850 mg/dl.

The value of fasting plasma glucose (FPG) levels and fasting salivary glucose (FSG) levels in the diabetic and controls and there mean and standard deviation shown in (Table I and Graph I). In diabetic group (n=60) the mean for FPG is 152.70 mg/dl with standard deviation of ±14.94 mg/dl and in controls (n=60) the mean for FPG is 68.20 mg/dl with standard deviation of ±14.631 mg/dl. The FSG levels in diabetic group (n=60) the mean for FSG is 15.158 mg/dl with standard deviation of ±1.7804 mg/dl and in controls (n=60) the mean for FSG is 3.176 mg/dl with standard deviation of ±1.2850 mg/dl. When FPG and FSG levels were compared between diabetic and control groups 'p' value (p=0.0001) was found to be statistically very highly significant.

Correlation between FPG and FSG levels of diabetics and controls based on Pearson correlation (2-tailed test) was given in (Table II). It is observed in diabetics group that the correlation between FPG and FSG levels were strongly positive (r=0.941). The control group also showed very strong correlation (r=0.945) between FPG and FSG levels. It is observed that in both diabetics and controls the p value (p<0.0001) was very highly significant.

Overall correlation between FPG and FSG levels among diabetics and controls based on Pearson Correlation (2-tailed test) was given in (Table III). It is observed that there was a strong positive correlation (r=0.992) between FPG and FSG values of diabetics and controls. The p value (p<0.0001) was found to be very highly significant between two groups.

## DISCUSSION

This study showed that there was a significant linear relationship between FPG and FSG The correlation coefficient between FPG and FSG level in diabetic patient was 'r'= 0.941 which is statistically very highly significant (p=0.0001).

Diabetes mellitus alters the constitution and flow of saliva; however extent of the alteration and its clinical significance has not been established. Biologically, it could be anticipated that salivary glucose levels in diabetics are higher than those in non-diabetics. Result of our study support this expectation and same observation is seen by others also.[3, 12, 13, 14]

Harrison and Brown suggested that glucose, being a small molecule, diffused easily through the semi-permeable membranes[15] this explains presence of glucose in saliva. In diabetics, a large amount of glucose becomes available to salivary glands. Alterations in the permeability, occurring as a result of basement membrane changes in diabetes, could be an additional explanation for increased concentrations of glucose in saliva.[13]

Table I Comparison of FPG and FSG levels between diabetics and controls

| Factor (mg/dL) | Diabetics (n=60) | | Controls (n=60) | | Significance |
|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | |
| FPG* | 152.70 | ±14.94 | 68.20 | ±14.631 | p=0.0001 |
| FSG** | 15.158 | ±1.7804 | 3.176 | ±1.2850 | p=0.0001 |

*Fasting plasma glucose, **Fasting salivary glucose, p=0.0001 very highly significant

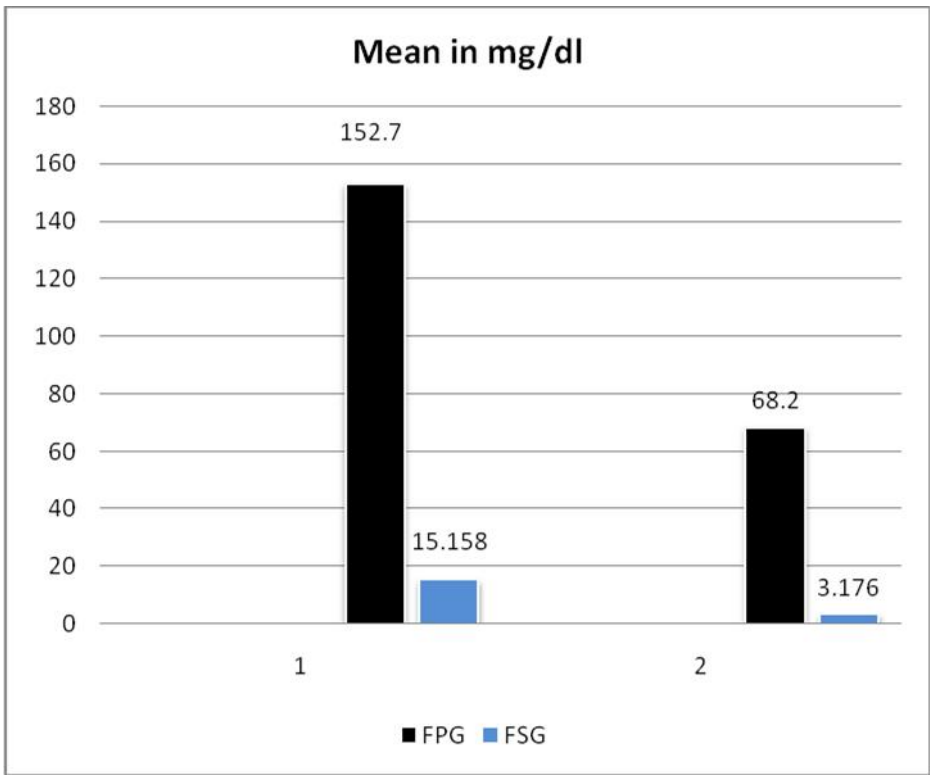
Table II Correlation between FPG and FSG in diabetics and controls

| GROUPS | | | FSG |
|---|---|---|---|
| DIABETICS | FPG | Pearson Correlation | 0.941** |
| | | Sig. (2-tailed) | 0.000 |
| | | n | 60 |
| CONTROLS | FPG | Pearson Correlation | 0.945** |
| | | Sig. (2-tailed) | 0.000 |
| | | n | 60 |
| **. Correlation is significant at the 0.0001 level (2-tailed). | | | |

Table III Overall correlation between FPG and FSG levels in diabetics and controls

| | | FSG |
|---|---|---|
| FPG | Pearson Correlation | 0.992** |
| | Sig. (2-tailed) | 0.000 |
| | N | 120 |
| **. Correlation is significant at the 0.0001 level (2-tailed). | | |

Graph I Comparison of FPG and FSG levels between diabetics and controls




According to the studies carried out by Harrison and Bowen, Reuterving et al., suggested that salivary flow rate affects glucose values.[15, 16] with increased salivary flow rate, salivary glucose values diminish due to dilution. The salivary flow rate in turn shows diurnal variation. In our study since all the salivary samples were collected at same time of the day,

therefore, salivary flow rate may not be responsible for the variations in salivary glucose values in the study.

Most of the study shows that fasting salivary glucose levels are increased in diabetes mellitus.[6, ,10, 11, 12, 13, 14] However, there are some controversies regarding few methods used for saliva collection. The salivary glucose levels may be affected due to following reasons such as storing of food carbohydrate in saliva, [17, 18] sugar consumption by mouth flora, [19] carbohydrate release by salivary glycoprotein[1, 5] and salivary contamination by elevated crevicular fluid in patients with gingival diseases.[5] In our study Navazesh method, the most accepted method for saliva collection was used to minimize all these above factors.[9]

Arti S. Panchbhai, et al. (2010) in their study demonstrated that fasting plasma glucose level is high in both uncontrolled and controlled diabetic group than in the healthy non-diabetic group also the mean salivary glucose levels were high in uncontrolled and controlled diabetic group than in the healthy non-diabetic group and the differences were highly significant. Uncontrolled diabetics had higher mean salivary glucose levels than controlled diabetics, [3] these results suggest that there is a definite correlation between FPG and FSG in diabetic patients.

Ana Carolina U. Vasconcelos, et al. (2010) did a comparative study to correlate glucose concentration in saliva and blood glucose in type II diabetes mellitus patients they demonstrated that the level of salivary glucose is augmented when the concentration of glucose in blood is elevated. The salivary glucose level in study group is 14.03±16.76 mg/dl and 6.35±6.02 mg/dl in control group. The capillary blood glucose level in study group 213±88 mg/dl, while in control group it is 99±14 mg/dl. Hence concluded that salivary glucose concentration was significantly higher in study group than in the control group.[4]

Anupama Hegde et al (2010) in their study demonstrated that significantly high fasting plasma glucose levels were found in the diabetic group, fasting plasma glucose showed positive correlation to salivary glucose but also concludes that conventional marker like fasting plasma glucose (FPG) is a better indicator of glycemic status.[20]

In our analysis, no statistical difference was observed in males and females of diabetics in fasting serum glucose (FPG) and fasting salivary glucose (FSG) values. A similar finding was observed in other studies also.[3, 5,]

In our study it was observed that as the age advanced the levels of FPG and FSG also increased consistently in diabetics, ($p=0.0001$) very high statistical significance was observed. In other similar studies, it was observed that serum glucose and salivary glucose levels increased with advancing age.[10, 13]

Veena V. Naik et al (2011) conducted a comparative and correlative study of glucose levels in serum and saliva of patients with diabetes mellitus. They had selected 200 study group confirmed patients of type II diabetes mellitus who were under medication and they had also selected 50 (control group) subjects who neither had past history of diabetes nor did their present glycemic status depicted high values. The glucose was detected in the saliva of both diabetic and non-diabetics. The fasting salivary glucose values in control group ranged from 4.1 to 13.3 mg/dl and the post prandial salivary glucose values from 12.5 to 20.0 mg/dl. Fasting salivary glucose values in the study group ranged from 4.1 to 26.6 mg/dl and post-prandial salivary glucose values from 15.3 to 30.7 mg/dl. It was observed that as blood glucose levels changed in both fasting and post-prandial sample, so did salivary glucose levels, irrespective of age and sex. A significant p value ($p<0.001$) and positive correlation

was found between blood glucose and salivary glucose levels in both the diabetic and the controls.[11]

Almost similar observation was seen in our study the fasting salivary glucose value in control group was seen with mean value of 3.176±1.2850 mg/dl and fasting salivary glucose value in study group was seen with the mean value 15.158±1.7804 mg/dl. A highly significant p value (p=0.0001) and a positive correlation (r=0.941) was found between blood and salivary glucose levels in both diabetic and the controls in fasting state.

The main aim of this study was to compare and correlate between serum and salivary glucose values in type II diabetes mellitus patients. It was found that the mean level of salivary glucose in diabetics is significantly very higher than the mean level of salivary glucose in non-diabetics and a linear strong positive correlation was established between salivary glucose and blood glucose. Supported by the data from other studies, we suggest that salivary glucose has very high potential as a marker in diagnosis and monitoring of diabetes mellitus.

## CONCLUSION

Based on the observations from our study it can be inferred that serum and salivary glucose levels were significantly higher in diabetic subjects. Increased amount of salivary glucose levels were seen only in diabetic patients and no difference was seen in control group. Thus it can be recommend that fasting salivary glucose values can be used for screening of diabetes. This will reduce the burden on diabetic patients who are subjected to repeated blood and urine examination. Thus saliva can be used alternatively as a diagnostic marker in diabetes mellitus. However, longitudinal controlled studies with stricter inclusion and exclusion criteria in larger population and analysis of treatment modality and duration of diabetes mellitus would be required to convert this potential into clinical application.

## REFRENCES

1. American Diabetes Association. Diagnosis and Classification of Diabetes Mellitus. Diabetes Care, January 2012; Volume 35: 64-71.
2. Annika Borg and Dowen Birkhed. Secretion of Glucose in Human Parotid Saliva after Carbohydrate Intake. Journal of Dental Research 1988; 96: 551-556.
3. Arati S. Panchbhai, Shirish S. Degwekar and Rahul R. Bhowte. Estimation of Salivary Glucose Salivary Amylase, Salivary Total Protein and Salivary Flow Rate in Diabetics in India. Journal of Oral Science 2010; Vol. 52: No. 3: 359-368.
4. Ana Carolina U. Vasconcelos, Maria Sueli M. Soares, Paulo C. Almedia nad Reresa C. Soares. Comparative Study of the Concentration of salivary and blood glucose in type 2 diabetic patients. Journal of Oral Science 2010; Vol.52: No.2: 293-298.
5. Anthony T. Vernillo. Diabetes mellitus: Relevance to dental treatment. J Oral Surgery Oral Medicine Oral Pathology. 2001; 91:263-70.
6. Bakianian Vaziri, M. Vahedi, H. Mortazavi, Sh. Abdollahzadeh, M.Hajilooi. Evaluation of Salivary Glucose, IgA and Flow Rate in Diabetic Patients: A Case-Control Study. Journal of Dentistry, Tehran University of Medical Science 2010; Vol.7: No.1:13-18.
7. Biljana Andjelski-Radičević, Radica Dožić, Tatjana Todorović, Ivan Dožić. Biochemical Markers in saliva of patients with diabetes mellitus. Sabian dental journal 2012; vol. 59: No.4: 198-201.
8. Borg, Andresson A, Birkhed D, Berntorp K, Lindgarde F, Matsson L. glucose concentration in parotid saliva after glucose, food intake in individuals with glucose intolerance and diabetes mellitus. Eur J Oral sci. 1998 Oct; 106(5):931-937.
9. Mahvash Navazesh and Satish K.S. Kumar. Measuring salivary flow Challenges and opportunities. JADA, 2008; Vol. 139:35-40.

10. Nagalaxmi V, Priyanka V. Can Saliva Be a Marker for Predicting Type 1 Diabetes Mellitus?-A Pilot Study. JIOMR, October-December 2011; 23(4):579-582.
11. Veena V. Naik, Yasmin Satpathy, Ganga S. Pilli, Mishra Mithilesh N. Comparison and Correlation Of Glucose Levels In Serum And Saliva Of Patients With Diabetes Mellitus. Indian Journal of Public Health Research & Development. Jan-June, 2011; Vol. 2: No.1: 103-105.
12. Mehrotra K.K., Chawla T.N., Abhay Kumar. Correlation of salivary sugar with blood sugar. Journal of Indian dental association. October 1968; 265-268.
13. Sonia Behal, Shailesh Lele. Correlation of Salivary Glucose with Blood Glucose in Diabetic Individuals. Indian Journal of Stomatol 2012; 3(4):212-16.
14. Seyyed Omid Mahdavi, Sedighe Hashemi, Najmeh Sadat Bootani, Haleh Zokaee. A New Method to Evaluate Fasting Plasma Glucose by Salivary Glucose Measurement. Iranian Journal of Diabetes and Obesity. 2012; Vol 4: No.3: 33-38.
15. Rosamund Harrison, William H. Bowen. Flow Rate & Organic Constituents of Whole Saliva in Insulin Dependent Diabetes Children's & Adolescents. Journal of Pediatric Dentistry: December 1987; Vol. 9: No. 4: 287-291.
16. Reuterving CO, Reuterving G, Hagg E, Ericson T. Salivary Flow Rate and Salivary Glucose Concentration in Patients with Diabetes Mellitus in Patients Influence of Severity of Diabetes. Journal of Diabete Metab. 1987 Jul-Aug; 13 (4): 457-462.
17. Karjalainen KM, Matti L.E. Knuuttila, Marja-Liisa Kaar. Salivary Factors in Children and Adolescents with Insulin-Dependent Diabetes Mellitus. American Academy of Pediatric Dentistry. 1996; 18: 306-311.
18. Radhika Sashikumar, and Ranganathan Kannan. Salivary Glucose Levels and Oral Candidal Carriage in Type II Diabetics. OOOOE 2010; Vol.109: No.5.
19. Hans Schneider, Jonathan Shaw, Paul Zimmet. Guidelines for the Detection of Diabetes Mellitus Diagnostic Criteria and Rationale for Screening. Journal of Clinical and Biochemical Rev. 2003; Vol 24:77-80.
20. Anupama Hegde, Ramya Shenoy, Prajwal D'Mello, Smitha A, Tintu A, Poornima Manjrekar. Alternative Markers of Glycemic Status in Diabetes Mellitus. Journal of Biomedical Research 2010; 21(3): 252-256.