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Original Research Article

Correlation of salivary glucose level with blood glucose level in diabetes mellitus: a cross sectional study

Reeta Baishya[1]*, Mangala Lahkar[2], Madhurima Bora[3], Arijit Mazumdar[4]

[1]Department of Physiology, [2]Department of Pharmacology, Gauhati Medical College, Guwahati, Assam, India
[3]Department of Biochemistry, Kokrajhar Medical College and Hospital, Rangalikhata Kokrajhar (BTR), Assam, India
[4]Department of Physiology, Royal School of Medical and Allied Sciences, Guwahati, Assam, India

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***Correspondence:**
Dr. Reeta Baishya,
E-mail: sahariareeta@gmail.com

ABSTRACT

Background: There is alarming rise in number of people with diabetes mellitus over these years. Type 2 diabetes mellitus is the fifth most common condition and the sixth leading cause of mortality amongst the elderly. Finding a relationship between the blood glucose level and its concentration in other body fluids such as the saliva can help in developing an on invasive method for blood sugar assessment replacing venous sampling. Objective of this study was to see the correlation between fasting blood glucose and fasting salivary glucose levels.
Methods: This cross sectional study included 200 randomly selected subjects, of which 100 were known diabetes constituted test group and 100 were normal healthy subjects, age- and sex-matched individuals constituted the controls. Fasting blood glucose and salivary glucose levels were measured by using glucose oxidase peroxidase methods. Data were recorded on a preforma in Microsoft excel sheet. Pearson's coefficient of correlation was applied to find out any significant correlation between the fasting blood glucose and fasting salivary glucose levels.
Results: Results were obtained by statistical calculation and plotted with respect to scatter and bar diagram was done and a $p<0.05$ was considered significant (with 95% CI).
Conclusions: A significant positive correlation exists between fasting blood glucose and fasting salivary glucose in both the test groups.

Keywords: Diabetes, Fasting blood glucose, Fasting salivary glucose

INTRODUCTION

Diabetes mellitus (DM) is perhaps one of the oldest diseases known to human kind. Egyptian manuscript reported it for the first time about 3000 years ago.[1] DM is a combination of heterogeneous disorders commonly presenting with glucose intolerance as well as hyperglycemia, as a result of lack of insulin, defective insulin action, or both.[2] Diabetes has become a common global health problem worldwide. It has turned out to be one of the leading reasons of death and disability.[3] The International Diabetes Federation's most recent estimates indicate that around 8.3% of adults (382 million individuals) are suffering from this disease.[4] The main concern is that this figure is set to rise further by 592 million in not more than 25 years. With 175million of undiagnosed cases at present, an enormous crowd with diabetes are rolling in the direction of complications unprepared.[4] Prevention, well-timed diagnosis and management are important in patients with DM.[5] Type 2 diabetes makes up about 85-90% of all cases.[6,7] Without timely diagnosis, complications and morbidity from diabetes rises exponentially.[8] Early diagnosis of diabetes is essential to prevent its devastating complications. The current method of investigation needs the painful needle-prick to withdraw blood. These are invasive procedures and offer a great deal of discomfort and anxiety, especially to pediatric and geriatric patients. Considering this, there is acritical need for the development of noninvasive procedure for diagnosing and monitoring diabetes.[9] Saliva is an organic fluid and it offers some distinctive advantages. Accordingly, saliva can reflect the physiologic state of the body including emotional, endocrinal, nutritional, and metabolic variations, and acts as a source for monitoring oral and systemic health.[10] It is easy to collect by non-invasive means and can easily be preserved. Whole saliva can be collected by an individual with limited training. Diagnosis of disease via the analysis of saliva is potentially valuable for children and older adults. Analysis of saliva may provide a cost-effective for the screening of large populations. Saliva is said to be the ultrafiltrate of blood. Saliva mainly consists of water, essential electrolytes, glucose, amylase, glycoproteins, antimicrobial enzymes.[11,12] Glucose is one of the blood components that are transferable across the salivary gland epithelium in proportion to its concentration in blood. Majority of molecules present in blood or urine can also be detected in salivary secretions, but in very less amount than those found in blood.[13] Increased blood glucose level also raises the salivary glucose level.[14]

Criteria for the diagnosis of diabetes mellitus: FPG≥126 mg/dl (7.0 mmol/l), fasting is defined as no caloric intake for at least 8 hours; 2-hours plasma glucose ≥200 mg/dl (11.1 mmol/l) during an OGTT; and HbA1C≥6.5% (48 mmol/mol). In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dl (11.1 mmol/l).[15]

Aim of the study was to evaluate the correlation between blood glucose levels and salivary glucose levels in normal healthy individuals and type 2 diabetic patients.

METHODS

The study type was cross sectional. The study was conducted at Gauhati Medical College and Hospital, Guwahati. Study carried out from October 2021 to November 2021. The IEC permission taken for the study.

Criteria for inclusion of the cases were those persons with age more than 35 years and less than 70 years. Both genders were inclusive in the study. The cases were all patients of type-2 diabetes mellitus. The cases excluded were type-1 diabetes mellitus patients. Also, those with severe diabetic complications and other systemic diseases were not taken in the ambit of the study. Those patients taking medications other than oral anti diabetic drugs were not considered. Smokers, alcoholics, pregnant ladies were left out of the study. Patients with xerostomia were not taken in the study. Statistical calculation was carried out by analyzing the data on Microsoft excel and p value was determined using double factor analysis of variance (ANOVA) and analyzed accordingly.

Study population was in following groups: test group-consists of 100 cases of diabetic whose fasting blood glucose levels is in the range of 126-200 mg/dl; and control group–consists of 100 non diabetic healthy controls with fasting blood glucose levels in the range of 80-126 mg/dl.

Male and female ratio was almost 50:50 while selecting the 100 non-diabetic and 100 diabetic cases.

Diabetic population were on oral anti-diabetic medications. However, their health status were normal without any complications.

All subjects were thoroughly informed about the study objectives and written informed consent was obtained from them.

Blood collection for glucose estimation

A volume of 2 ml of peripheral venous blood was collected from the ante cubital vein with syringe into a sterile test-tube for the estimation of fasting blood glucose levels.

Saliva collection for glucose estimation

Unstimulated saliva has been used because of the possibility of dilution and modulation of PH in stimulated saliva. Unstimulated fasting saliva were collected using the “spit technique.” The subject was asked to siting a chair with the head tilted forward and instructed not to speak, swallow or do any head movements during the procedure or swallow any saliva if present in the mouth. Then, he or she was instructed to spit in a sterile graduated container every minute for 10 mins. Each unstimulated saliva sample and blood sample was centrifuged at 3000 rpm for 20 min. Clear supernatants were processed immediately for estimation of glucose. HumaLyzer 3000 semi autoanalyzer was used for the estimation of glucose and readings were noted for both. Both the fasting blood glucose and glucose in unstimulated whole saliva were estimated using glucose oxidase peroxidase method.

RESULTS

A total of 200 participants, of which 100 diabetic patients (test group) and 100 normal + healthy person (control group) were included in this study. Male and female ratio equal for this study. The lowest value of fasting blood glucose was 70 mg/dl and highest was 90 mg/dl with a mean of 80.7±6.99 mg/dl in control group. The lowest value of fasting salivary glucose was 0.2 mg/dl and highest was 1 mg/dl with a mean of 0.56±0.287 mg/dl in control group.

P value significant 0.021. The coefficient r=0.23 positive correlation.

There is slight positive correlation between FBG and FSG i.e. rise of fasting blood glucose is correlated with slight rise of salivary glucose (Table 1).

Table 1: FBG-FSG correlations in control group.

Control (N=100)	FBG	FSG	r	P value
Mean	80.7	0.56	0.23 **	0.021
Std. deviation	6.99	0.287		

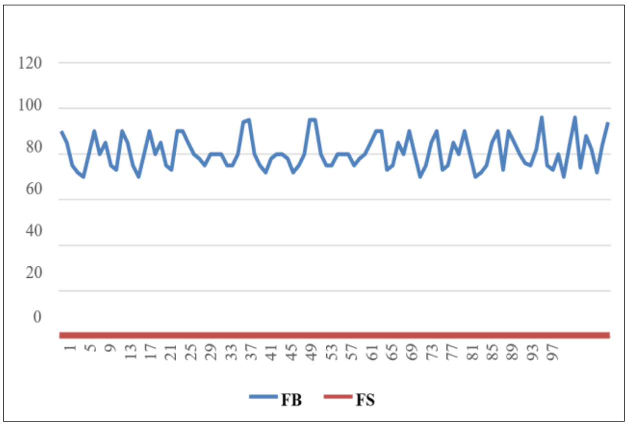

Figure 1: Line chart showing distribution of FBG and FSG in control group.

For the test group the lowest value of fasting blood glucose was 140 mg/dl and highest was 199 mg/dl with a mean of 167.91±14.69 mg/dl. The lowest value of fasting salivary glucose was 5 mg/dl and highest was 11 mg/dl with a mean of 7.3999±1.36 mg/dl in test group. P value is significant <0.05. The coefficient of correlation, r=0.74 which indicates a positive correlation.

Table 2: FBG-FSG correlations in test group.

Test (N=100)	FBG	FSG	r	P value
Mean	167.91	7.39	0.74 **	<0.005
Std. deviation	14.696	1.36		

Table 3: FBG-FSG correlations in control and test group.

Group	FBG	FSG	r	P value
Control (n=100)				
Mean	80.7	0.56	0.23 **	0.021
Std. deviation	6.99	0.287		
Test (n=100)				
Mean	167.91	7.39	0.74 ***	<0.005

There is positive correlation between FBG and FSG i.e. rise off fasting blood glucose is correlated with rise of salivary glucose.

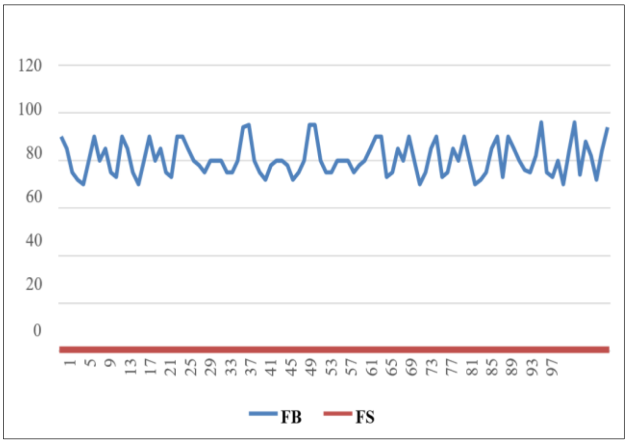

Figure 2: Line chart depicting the FBG and FSG in the test group.

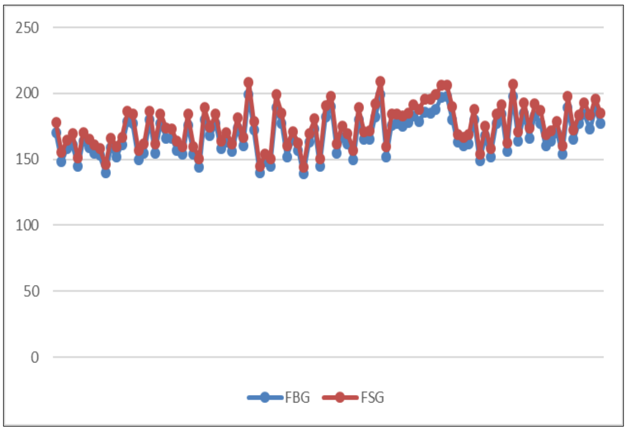

Figure 3: Stacked line with markers to depict change in FBG and FSG over time for each value.

Significant correlation was found between FBG level and FSG level of test group in comparison to slightly significant in control group.

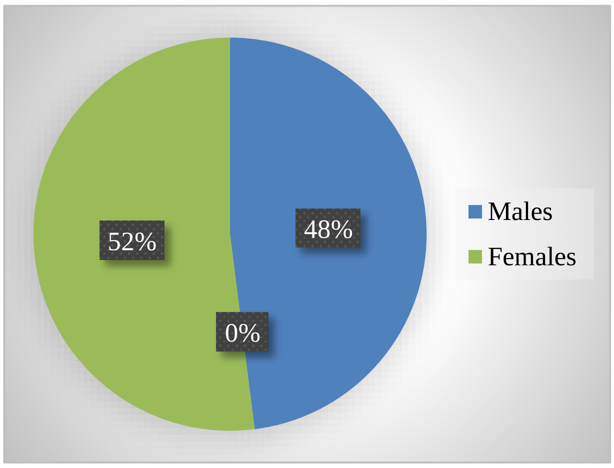

Figure 4: Pie chart depicting the percentages of males and females in control group.

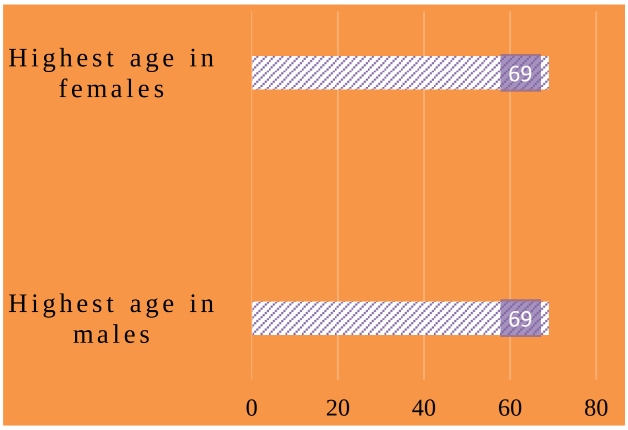

Figure 5: Cluster chart depicting highest age amongst gender in control group.

Figure 6: Cluster chart depicting the highest age in males and females in test group.

Table 4: Depicting the demographic lowest age pattern of control and test group.

Variables	Control group (years)	Test group
Lowest age of males	44	44
Lowest age of females	44	44

DISCUSSION

Diabetes is one of the globally wide-spread disease. Blood is taken as analytical body fluid for its diagnosis. A range of diagnostic devices are available in the market to determine the blood glucose level (BGL). A need arises to establish a noninvasive procedure to establish the glucose level without taking blood.[8] Of all salivary parameters, salivary glucose, appears to be most closely related to the oral environment in patients with diabetes. 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 non-diabetic individual is <2 mg/dl.[13]

In the present study, statistically significant correlation was found between fasting salivary glucose level (FSG) and (FBG) in patients with diabetes (test group) and controls group as well. Significantly higher mean FSG was found in group with diabetes (test group) compared to control group. For study group, the mean FSG was, 7.3999±1.36 mg/dl, and the mean FBG was 167.91±14.69 mg/dl. P value significant <0.05. Pearson's correlation, r=0.74.

Few studies that are documented had the values in accordance to our study. In the study by Panchbhai et al in 2010, the mean FSG was 7.64±6.44 mg/dl.[13] Panchbhai again did a study in 2012 and found FBG as 6.83 mmol/l.[10] The study done by Kumar et al had 7.4–17.8 mg/dl as SGL in controlled diabetic group.[14] Ravindran et al did a study and observed mean of FSG as 6.567±3.04 mg/dl for the diabetic group.[16] The study by Abikshyeet et al revealed the mean FSG as 4.22±3.59 mg/dl for diabetic group.[17] Soares et al obtained mean of FSG of diabetic group as 5.91±2.19 mg/dl.[18]

Many studies are acknowledged where the values of SGL of controlled diabetics did not match the values of our study. Harrison and Bowen conducted a study and recorded the SGL as 11.0±2 µg/ml for good controlled DM.[19] As for the study by López et al the values recorded for diabetic group was 1.48±2.15 mg/dl.[20] Studies conducted by Mussavira et al had 3.41 mg/dl as mean FSG in controlled diabetic group.[21] The study Mirzaii-Dizgah et al revealed mean SGL as 10.46±6.50 mg/dl for diabetic group.[22] FSG was 10.4–15.5 mg/dl in the study by Kumar et al.[17] Satish et al found FSG for diabetic group as 12.11±6.38 mg/dl.[23]

Few studies had values of FBG in accordance to our study. In the study by Agrawal et al, the mean FBG of the patients in diabetic group was 171.31±54.23 mg/dl, and the mean FSG of the patients in diabetic group was 10.93±1.93 mg/dl.[24] Mirzaii-Dizgah et al found FBG as 134–336 mg/dl and FSG as 9–15 mg/dl for diabetic group.[22] FSG was 10.4–15.5 mg/dl in the study by Kumar et al.[14]

In our study for control group healthy nondiabetic group, the mean of FSG level was 0.78±0.09 mg/dl, and the mean of FBG level was 78.39±9.25. P value significant 0.021. The coefficient, r=0.23 positive correlation showed significant correlation.

Few studies that are documented had the values in accordance to our study. López et al conducted a study and revealed 0.75±1.57 mg/dl as SGL for nondiabetics.[20] 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.[17] Shahbaz et al obtained mean of FSG of the healthy group as 0.813±0.077 mg/dl, and mean FBG as 82.96±6.92 mg/dl for the same group.[25] Kumar revealed mean FSG for healthy individuals as 0.64±1.23 mg/dl and mean FBG as 115.78±21.04 mg/dl.[26] The study done by Panchbhai et al had 1.89±1.44 mg/dl as SGL in nondiabetic group.[10]

Mirzaii-Dizgah et al revealed mean FBG as 74–118 mg/dl and mean FSG as 0–7 mg/dl.[22] In a study done by Mussavira et al, the healthy group had mean FSG as 2.07 mg/dl.[17] Ravindran et al did a study and observed mean of FSG as 1.867±0.9732 mg/dl for the nondiabetic group.[21] Satish et al in their study obtained mean FSG as 4.32±0.62 mg/dl and mean FBG as 90.5±11.19 mg/dl.[23] Many studies have been conducted, and their values of SGL for healthy group did not match the values of our study. The study done by Hegde et al the values recorded for healthy group was 7.41±3.44 mg/dl.[27]

Harrison and Bowen did a study and recorded the SGL as 5.0±1.0 μg/ml for healthy subjects.[19] The studies 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.[24] Gupta et al concluded the mean FSG for healthy individuals as 6.58 mg/dl.[28] Numerous researchers have worked in the field of salivary diagnostics for diabetes mellitus.

Limitations

The study had its own limitations with difficulty in collecting specimens for salivary glucose. Although this study focusses on the non-invasive method of estimating glucose level in the body but larger study with more number of cases should be carried out to establish the firmness of the finding of this study. There should be disposable gowns and face cover available for the technicians who collect saliva which was totally not possible in the study.

CONCLUSION

This study reveals that salivary glucose is increased in diabetics. Significant positive correlation was found between FSG level and FBG level of diabetics. Similar effect was noticed between salivary and blood glucose values in control group of healthy non diabetics which helps us to arrive at the conclusion that saliva can be used as adjuvant diagnostic tool to blood in early diagnosis for diabetes mellitus. Saliva also finds great advantage over blood in case of children, elderly, critically ill and debilitated patients as it is a noninvasive method. The standardized procedure of salivary glucose estimation for diabetes mellitus is likely to make this new noninvasive method of diagnosis a futuristic diagnostic tool.

Recommendations

In the coming times further studies can be undertaken involving larger sample size, using different methods of saliva and blood collection, by taking parameters like glycosylated hemoglobin to estimate glucose level in the body. The patients who are on medications show alteration in salivary secretion and its flow, and these criteria must be taken into consideration. The standardized procedure of salivary glucose estimation for DM may herald a new era in non-invasive method of diagnosis.

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