ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2019; 5(1): 257-259

www.oraljournal.com
Received: 25-11-2018
Accepted: 29-12-2018

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A non-invasive approach for detection of salivary glucose level and its correlation with blood glucose level in patients with diabetes mellitus

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Abstract
Introduction: Saliva is a unique fluid, which is important for normal functioning of the oral cavity. Diabetes mellitus (DM) is a disease of absolute or relative insulin deficiency characterized by insufficient secretion of insulin by pancreatic beta-cells. The diagnosis of diabetes through blood is difficult in children, older adults, debilitated and chronically ill patients, so diagnosis by analysis of saliva can be potentially valuable as collection of saliva is noninvasive, easier and technically insensitive, unlike blood. 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: A study was conducted in 40 patients who fulfilled the selection criteria. Patients were categorized into 2 groups -20 patients with diabetes mellitus (Group A) and 20 healthy non-diabetic patients (Group B). The fasting blood and unstimulated saliva samples were collected from the patients. These samples were estimated using the glucose oxidase-peroxidase method.
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 (181.55±12.67) and fasting blood glucose level among group B was 73.59±7.56. The mean FSG was higher in diabetic group (13.43± 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: In this study, an attempt has been made to diagnose diabetes mellitus by estimating the salivary glucose level in comparison with serum blood glucose level. 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 remains to be a global health concern with an estimated of 422 million people affected worldwide [1]. In the Philippines, while there are more than 4 million Filipino adults reported with the disease, a large unknown number remains undiagnosed. The figure translates to one in every five Filipinos likely to have diabetes or pre-diabetes [2]. Early and effective screening of diabetes is an important strategy to reduce the incidence of the disease and its complications. Blood testing remains to be the gold standard in the diagnosis but this can be invasive and painful for most patients leading to anxiety, risk of infection and the need for skilled phlebotomist [3]. This painful experience could lead to profound health, societal, psychological, and social consequences and is highly associated with an avoidance behavior. Fear and anxiety to needles may result in non-compliance with health care services, such as performance of blood tests [4]. Studies that explore the diagnostic value of salivary glucose are promising due to the non-invasiveness of the test procedure and its potential correlation with blood results. The human saliva, an exocrine fluid secretion, has high potential for screening health and diseases [5, 6]. It consists of water, electrolytes and variety of proteins like enzymes, immunoglobulins, albumin, some polypeptides and biomarkers which can be useful for rapid tests. Studies show that proteins present in blood are present in saliva as well [5]. Therefore, saliva is functionally comparable to blood in reflecting the physiological status of the body [7].

Because of its potential clinical value, there is an increase use of saliva in the diagnosis for diseases. The collection of saliva is also easier and non-invasive compared to collection of blood [5, 7]. The aim of the present study is to compare the fasting salivary glucose level with fasting serum blood glucose level in individuals with diabetic mellitus and nondiabetic individuals, and the objective of the study is to assess the validity of saliva in diagnosing diabetes mellitus.

Material and method

The study was conducted in our department with the inclusion criteria, where the patients with diabetes where considered as case, and nondiabetic were considered as control. The exclusion criteria are pregnant females, patients with habit of smoking and chewing tobacco, and patients suffering from systemic ailment.

After patients were detailed about the study protocol, a written consent was obtained. The saliva sample were collected by making the patients to rinse his/her mouth with water and were insisted to open mouth for 5 min without swallowing, and about 1 mL of saliva was collected in a sterile container by the suction method. Serum was collected by venipuncture; blood was collected in a sterile container. Both serum and salivary glucose level were estimated using the glucose oxidase-peroxidase (GOD-POD) method.

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 40 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 181.55±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 (13.43± 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*).

Table 1: Correlation of Mean Fasting Blood Glucose level among both group

Group	Mean ± SD	p
Group A	181.55±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 2: Correlation of Mean Fasting Serum Glucose level among both group

Group	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 3: Correlation between FBG and FSG for Group A and Group B

Group	Fasting Blood Glucose level	
Group A (n=20)	Fasting Salivary Glucose level	Correlation coefficient (r) 0.849 P value 0.0001*
Group B (n=20)	Fasting Salivary Glucose level	Correlation coefficient (r) 0.789 P value 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

Discussion

Salivary glucose has been investigated by various studies as a non-invasive alternative in overcoming the problems associated with blood glucose monitoring. But because contradicting results are obtained, the idea of saliva being an effective replacement for blood glucose is still debatable [8, 9]. Several studies suggest that significant correlation exist between salivary and blood glucose and would be helpful in monitoring diabetes. Considering that the procedures for glucose monitoring today are invasive, saliva can therefore serve as an alternative non-invasive diagnostic fluid to help overcome this problem. Saliva testing therefore surpasses all of the limitations of venipuncture and provides the ease of testing among all age groups [10, 11]. 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 [12]. There is lack of consensus among different authors on the utility of saliva for monitoring glycemic control.

In the present studies Diabetic group (Group A), the mean FSG was 6.13 ± 3.2 mg/dl, and the mean FBG was 181.55 ± 12.67 mg/dl. Pearson's correlation test showed significant correlation at 0.01 level. Similar result was found in the study by Abikshyeet *et al*. revealed the mean FSG as 4.22 ± 3.59 mg/dl for diabetic group [13] and Panchbhai *et al*. in 2010, recorded a mean FSG of 7.64 ± 6.44 mg/dl [14].

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 [15]. 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 [13].

Conclusion

Frequent monitoring of glucose level is required to reduce its complication. The outcome of the present study showed distinct difference was observed between normal and diabetic patients suggesting that monitoring of salivary glucose level can be used as an index of diabetes mellitus. Further studies on large sample size should be done to ascertain the diagnostic valuability of salivary glucose level in the early diagnosis of diabetes mellitus.

Acknowledgment
The authors would like to thank Royal Diagnostic Center, Ranchi for providing the material for study.

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