Journal of Pharmaceutical Research International

32(20): 20-27, 2020; Article no.JPRI.59846
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Estimation of Salivary and Blood Glucose Level among Patients with Diabetes Mellitus – A Comparative Study

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Authors' contributions

This work was carried out in collaboration between both authors. Author MS designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the literature searches. Author SD managed the analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2020/v32i2030725
Editor(s):
(1) Dr. Thomas F. George, University of Missouri-St. Louis and University of Boulevard St. Louis, USA.
Reviewers:
(1) Muhammad Zahoor Khan, China Agricultural University, China.
(2) Nadia Abdulkarim Salih, University of Sulaimani, Iraq.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59846

Original Research Article

Received 28 May 2020
Accepted 03 August 2020
Published 26 August 2020

ABSTRACT

Diabetes mellitus (DM) is a clinical syndrome characterized by hyperglycemia because of the absolute or relative deficiency of insulin. It requires frequent monitoring of glucose levels in the body which requires multiple pricking at regular intervals. It could be physically and psychologically traumatic to the patient. This necessitates an alternative to measure the glucose level. This study aims to correlate the salivary glucose level with the blood glucose level in diabetes patients. The cross-sectional study was conducted in 60 patients. Patients were categorized into two groups as Group A- 30 patients with diabetes and Group B- 30 healthy subjects. The blood and saliva samples were collected from the patients and the glucose levels were recorded. All these data were entered in Microsoft Excel and analyzed statistically using SPSS software. The mean (±SD) value of the random blood and salivary glucose level in diabetic patients were found to be 251.4±82.66 and 2.85±0.85 respectively and the mean blood and salivary glucose level in healthy

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subjects were found to be 101.12±10.14 and 0.875±0.13 respectively. There was a significant correlation between the salivary glucose levels and blood glucose levels among diabetes (p-0.00) and healthy individuals (p-0.00). From the data, the diagnostic accuracy was found to be 100%. Thus, Saliva could be used as an alternative to blood for monitoring the glucose status in diabetes patients.

Keywords: Diabetes mellitus; salivary glucose; blood glucose; glycemic control.

1. INTRODUCTION

Diabetes has become a typical illness worldwide and it turned out to be one of the leading reasons for death and disability [1]. Diabetes mellitus is an advanced multisystemic disorder characterized by relative or absolute deficiency of insulin secretion and concomitant resistance to the metabolic action of insulin on target tissues [2]. The classification scheme for diabetes mellitus includes two major forms: type I (insulin dependent diabetes mellitus) and type II (non insulin dependent diabetes mellitus). Type II is the most common form of diabetes, which combines insulin resistance with an insulin secretory defect. Patients with type II diabetes mellitus have some endogenous insulin secretory capability and have obvious abnormalities of glucose homeostasis [3].

Owing to the lack of adequate diagnosis and treatment, diabetes may be a major reason behind death worldwide, over half the diabetics stay unknown. Without timely identification, complications and morbidity from diabetes rise exponentially [4]. Early diagnosis of diabetes is important to stop its devastating complications, the present methodology of investigation wants the painful needle-prick to withdraw blood, which can discourage the people from the investigation [5]. The diabetic patients who have been diagnosed need routine daily monitoring of glucose levels with the blood collection which could be traumatic [6]. This necessitates the need for alternative non invasive methods. Saliva has been put forth as a potential diagnostic tool for surveillance of disease due to its several advantages. It offers an inexpensive, simple and easy to use as screening method [7].

Saliva is a complex fluid, whose vital role is to keep up the well-being of the oral cavity [8]. Saliva can be gland specific saliva and whole saliva [9]. The composition of saliva is 99% of water and the remaining 1% which consists of massive organic molecules like proteins, glycoproteins and lipids, tiny organic molecules like glucose, urea and electrolytes such as sodium, calcium, chloride and phosphates [10]. Due to hyperglycemia in DM patients, the glucose metabolic product causes changes within the microvasculature and basal membrane of salivary glands and other oral mucosal tissues. This results in easier diffusion of glucose from serum to saliva and gingival crevicular fluid [11]. Membrane abnormalities of the parotid gland have been reported in diabetes [10].

Like the serum, saliva is a biological adjunct containing a variety of hormones, antibodies, enzymes, anti-microbial, and growth factors. Several of those enter saliva from the blood serum by passing through the spaces between the cells by transcellular or paracellular routes [12]. Therefore, most of the elements found within the blood serum are present in saliva, thus making saliva functionally equivalent to blood serum in reflecting the physiological status of the body, together with the secretion, nutritionary and numerous metabolic variations [13]. In diabetes patients, there was a reduced salivary pH, increased incidence of caries and periodontitis when compared to the control group. Diabetes has been also associated with altered salivary composition and function which disrupts the homeostasis of the oral cavity [14].

Saliva offers some distinctive benefits. Saliva can be collected non invasively and saliva can be collected by an individual with limited training. No special instrumentation is required for the collection of the fluid. Diagnosis of diabetes via the analysis of saliva is potentially valuable for children and older adults. The collection of fluid is related to fewer compliance issues as compared with the collection of blood. Analysis of saliva will offer an economical approach for screening of enormous populations [9]. Our recent research portfolio slides numerous articles in reputed journals [15–19]. Based on this experience, we planned to investigate the correlation between blood glucose levels with salivary glucose levels in diabetes patients.

2. MATERIALS AND METHODS

The present comparative cross sectional study was conducted in Saveetha Dental College

(Chennai, Tamilnadu, India). The study was conducted on individuals with age ranging from 40 to 75 years. The study comprised 60 patients and were categorized into 2 groups, each consisting of 30 patients with diabetes mellitus (Group A) and 30 healthy subjects (Group B).

2.1 Inclusion Criteria

30 patients diagnosed with diabetes mellitus in the age range of 40-75 years and 30 patients with no apparent medical history were included in the study.

2.2 Exclusion Criteria

Patients having other systemic diseases and patients with severe diabetic complications were excluded from the study.

2.3 Collection of Blood Sample

Under aseptic conditions using a sterile disposable needle, 2 ml of intravenous blood was collected from the antecubital vein [10].

2.4 Estimation of Salivary Glucose Level

The whole unstimulated saliva was taken for the estimation of salivary glucose levels. Subjects were asked to spit or swallow whatever saliva was present in the mouth initially and then the samples were collected. For the glucose estimation, glucose oxidase- peroxidase kit method was used [20]. Both the salivary and blood glucose level were recorded.

2.5 Statistical Analysis

The mean and standard deviation were calculated for individual groups. Data was entered in an Excel sheet and analysed using SPSS software. To determine the correlation between two variables Pearson's correlation test was used. Receiver operating curve (ROC) analysis was used to determine the specificity and sensitivity of salivary and blood glucose level. p-value lesser than 0.05 were considered statistically significant.

3. RESULTS AND DISCUSSION

A total of 60 patients were included in which 30 were diabetic and 30 were healthy subjects. Out of these diabetic patients, 60% were male and 40% were female. Among healthy subjects, 47% were male and 53% were female [Fig. 1]. In diabetic patients, the random blood glucose level ranged from 128-406 mg/dl and in the healthy subjects, the blood glucose level ranged from 84-120 mg/dl. The mean and standard deviation of random blood glucose level was 251.4±82.66 and the salivary glucose level was 2.85±0.85 in Group A (Diabetic). The mean and standard deviation of blood glucose level was 101.12±10.14 and the salivary glucose level was 0.875±0.13 in Group B (healthy subjects) [Table 1]. From the graphs, it was found that there was a positive correlation between the salivary and blood glucose levels in both diabetic and healthy subjects [Fig. 2]. By Pearson Correlation, it was found that there was a significant correlation between the salivary and blood glucose level in healthy individuals(p-0.00) and diabetes patients (p-0.00) [Table 2].

ROC curve analysis results indicate that the best cut off value of salivary glucose level was 1.30. From the results, we can infer that if a person's salivary glucose level was greater than 1.30, they may be said to be diabetic and on the other hand, if a person's salivary glucose level was lesser than or equal to 1.30, they may be said to be non diabetic [Fig. 3]. The ROC curve yielded a sensitivity and specificity of 100% with (95%CI :88.7,100). From the data, the diagnostic accuracy was found to be 100% [Table 3]. The p value obtained from the area under the curve was found to be statistically significant ($p<0.001$) [Table 4].

Diabetes mellitus is a group of complex metabolic disorders that share the common underlying feature of hyperglycemia which results either from defects in insulin secretion or action or most commonly, a combination of both. It is a condition that requires frequent monitoring of glucose levels [21]. The two key aspects of diabetic management are the normalization of

Table 1. Table showing the comparison of blood glucose and salivary glucose level between diabetic and normal subjects

Groups	Blood glucose level	Salivary Glucose level
Group A(n=30) Diabetic	251.4±82.66	2.85±0.85
Group B(n=30) Healthy subjects	101.12±10.14	0.875±0.13

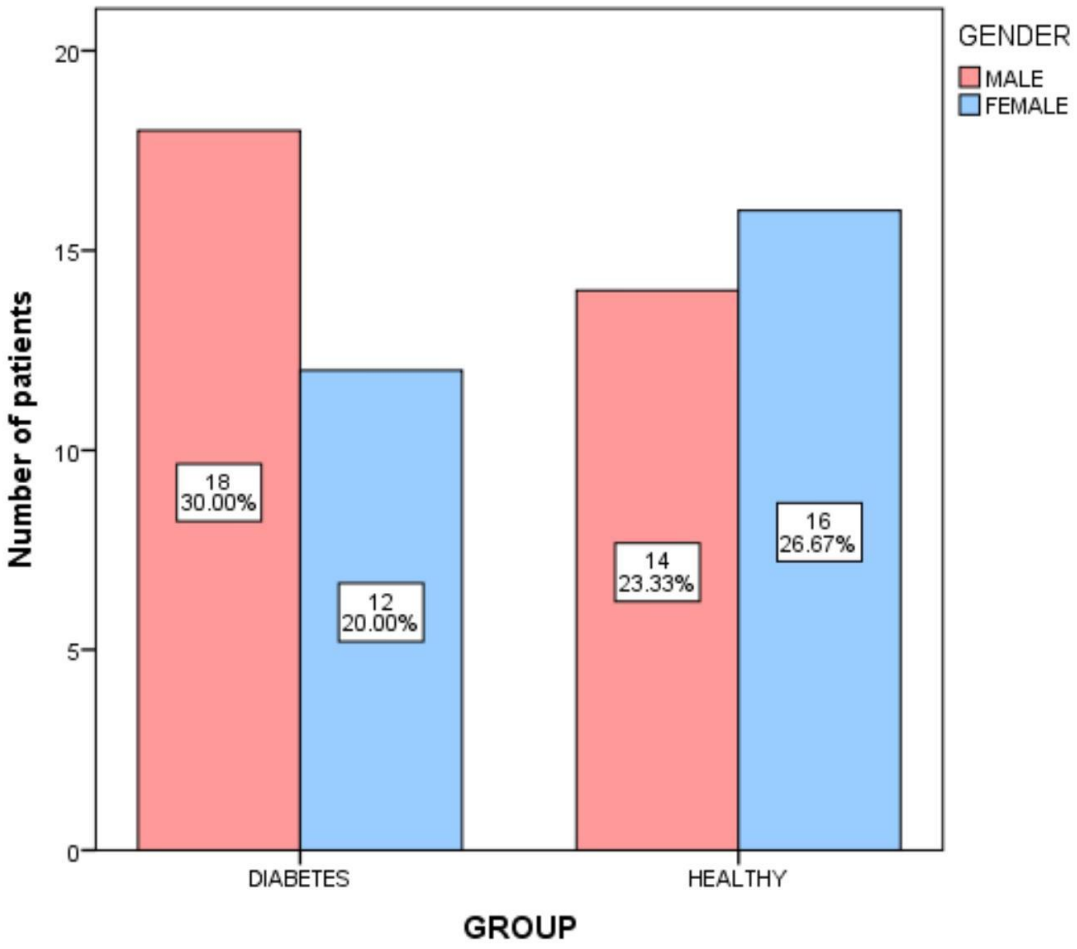

Fig. 1. Bar graph showing the gender distribution among diabetic and healthy individuals

The X-axis represents diabetic patients and healthy individuals and the Y-axis represents the number of patients. The highest number of patients with diabetes were males and among the healthy subjects, it was found to be females

blood glucose level and its regular monitoring [5]. Currently, the diagnosis as well as regular monitoring of diabetes mellitus is achieved only by analyzing blood glucose level which is an invasive procedure [21]. Apart from physical trauma, the process also renders mental trauma and anxiety about the procedure to discourage patients further [5].

Table 2. Correlation of salivary glucose and blood glucose level in diabetic and healthy individuals using pearson's correlation test

Correlation	Pearson Correlation	p value	n
Diabetic	0.950	0.000	30
Healthy subjects	0.842	0.000	30

Table 3. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of salivary and blood glucose levels

Parameter	Estimate	95% CIs
Sensitivity	100%	(88.7, 100.0)
Specificity	100%	(88.7, 100.0)
Positive Predictive Value	100%	(88.7, 100.0)
Negative Predictive Value	100%	(88.7, 100.0)
Diagnostic Accuracy	100%	(94.0, 100.0)

Saliva plays a key role in the maintenance of homeostasis of the oral cavity as it stabilizes the

ecosystem of the oral cavity and it serves as an early marker of many diseases [22,23]. Saliva is considered as an ultrafiltrate of blood. Whole saliva is a biological fluid which is simple to collect [24].

Table 4. Area under the curve obtained by the ROC curve analysis

Area under the curve	95% CI		p-value
	LB	UB	
1.000	1.000	1.000	<0.001

The biochemistry reveals that the normal value of salivary glucose in a healthy non-diabetic individual was less than 2 mg/dl [25]. Diabetes patients have significantly lower salivary flow rate, pH, and buffering capacity and present with advanced periodontal destruction than the healthy population and the study stated a positive correlation between blood glucose and salivary glucose level [6]. Another study estimated the salivary glucose level and stated that there was a high statistical significance between the serum blood glucose level and salivary glucose level. In the study, the mean blood glucose and the salivary glucose level in healthy control were 98.4 mg/dl and 0.4 mg/dl respectively. The mean blood glucose and the salivary glucose level in diabetic control were 288.7 mg/dl and 3.65 mg/dl respectively. The study also concluded that saliva can be used as a screening method in diagnosing diabetes mellitus [20]. In our study, the mean value of blood and salivary glucose level in diabetes was 251.4 mg/dl and 2.85 mg/dl respectively and the mean value of blood and salivary glucose level in healthy subjects was 101.1 mg/dl and 0.87 mg/dl respectively.

A study estimated salivary and serum biomarkers in diabetic and non diabetic patients. The study stated that there was a highly significant correlation between blood glucose level and salivary glucose level. He also stated that there was a significant correlation between serum glucose levels and amylase, total proteins, albumin and globulin in diabetes mellitus patients. He concluded that the salivary parameters can be used for screening, diagnosing and monitoring of diabetes mellitus to blood [26].

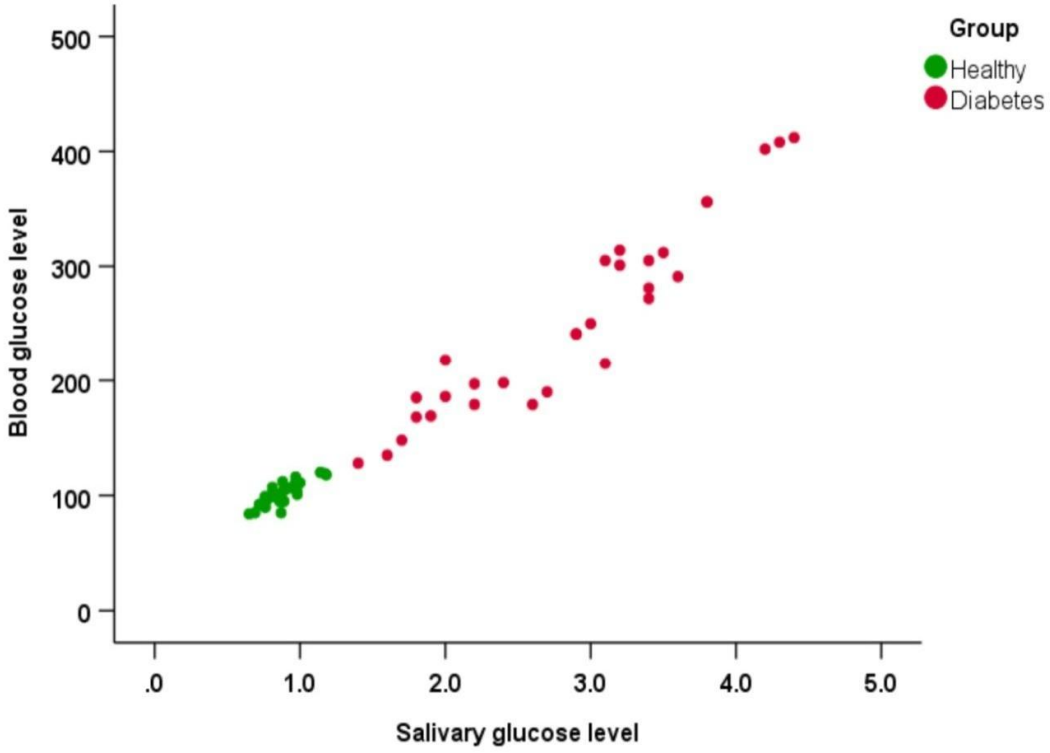

Fig. 2. Scatter plot graph showing the correlation of salivary glucose level and random blood glucose level in healthy and diabetic individuals

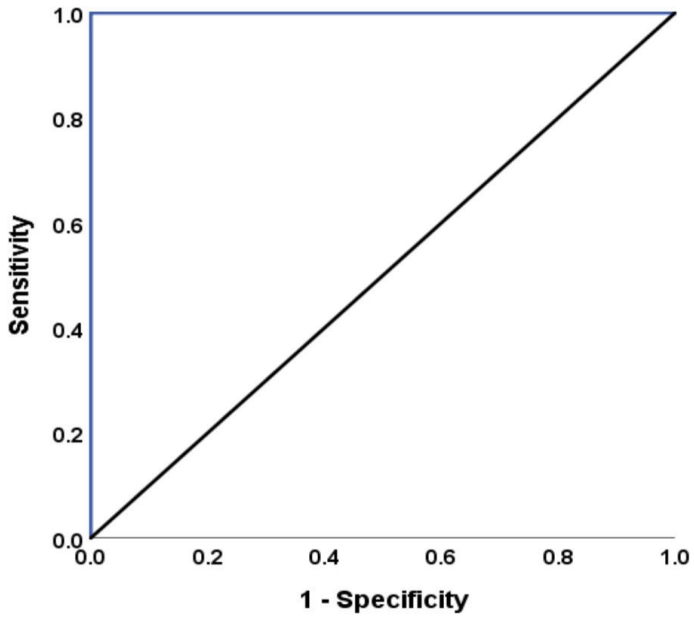

Fig. 3. Roc curve analysis for salivary and blood glucose level

A study analyzed the correlation between blood and salivary glucose level in diabetic patients. The study stated that there was a high correlation between blood glucose level and salivary glucose level in diabetic patients. The mean (±SD) blood glucose and salivary glucose level was 247±24.2 mg/dl and 1.4±0.2 mg/dl in the diabetic group respectively. The mean blood and salivary glucose level was 84.97±15.8 mg/dl and 1.09±0.12 mg/dl [27]. In our study, the mean±SD blood glucose and salivary glucose level in the diabetics patients were 251.4±82.66 and 2.85±0.85 respectively and the mean±SD blood glucose and salivary glucose level in healthy subjects were 101.12±10.14 and 0.875±0.13 respectively. In accordance to other studies [2,5,21,22], we concluded that there was a positive correlation between the blood glucose level and salivary glucose level.

4. CONCLUSION

Within the limitations of the study, it was concluded that there was a significant correlation between blood glucose levels and salivary glucose levels. Thus, Saliva could be used as a non-invasive alternative to blood for diagnosis and monitoring glucose status in diabetic patients and can be easily collected from children, elderly and critically ill patients.

5. LIMITATIONS

The correlation between the blood glucose level and salivary glucose level was observed with the fact that the subjects examined represent a selected population. Further studies can be done with a larger sample size.

CONSENT AND ETHICAL APPROVAL

Participants were informed about the study protocol and blood and saliva samples were obtained from each participant. Approval from the institutional ethical committee was taken before starting the study.

ACKNOWLEDGEMENT

The authors of this study would like to express that gratitude towards everyone who facilitated and enabled us to carry out this successfully.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/59846