Assessment of Blood Glucose Level using Gingival Crevicular Blood in Diabetic Patients: A Cross-sectional Study

Vijayavel Ponni, Tirupathy Manigandan, Sanarpalayam Chinnasamy Selvamuthukumar

ABSTRACT

Background: Diabetes mellitus (DM) is one of the most frequent metabolic disorders which is often undetected in approximately one-third of the patient population. The prevalence of diabetes mellitus is high in patients with periodontitis. Hence, dentists play a vital role in the detection of undiagnosed diabetes mellitus in many patients.

Aim: The purpose of the study was to evaluate whether the blood oozing from the gingival crevice during routine examination could be used for determining glucose levels.

Materials and methods: In the present study, 100 patients (50 diabetic and 50 nondiabetic) with chronic Periodontitis were selected and were divided into two groups, i.e. group I (Diabetic) and group II (Nondiabetic), respectively. Blood oozing from the gingival crevices of anterior teeth following periodontal probing was collected with the strip of glucose self-monitoring device and the blood glucose levels were measured. At the same time, finger-prick blood was taken for glucometric analysis and also, intravenous blood was collected for measurement in a laboratory glucose analyzer.

Results: The patients' blood glucose values ranged from 77 to 480 mg/dl. The comparison between gingival crevicular blood (GCB), Finger-Prick blood (FPB) and intravenous blood (IVB) showed a very strong correlation with a r-value of 0.99 (p < 0.001).

Interpretations and conclusion: The data from this study has shown that GCB collected during intraoral examination is an excellent source of blood for glucometric analysis.

Keywords: Diabetes mellitus, Gingival crevicular blood, Chronic periodontitis, Finger prick blood, Intravenous blood.

INTRODUCTION

Diabetes mellitus is a metabolic disorder of multiple etiologies characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.1

Diabetes mellitus is associated with a wide range of complications, such as retinopathy, nephropathy, neuropathy, micro and macrovascular diseases,2 altered wound healing and periodontitis.3,5 Moreover, diabetes and periodontitis seem to interact in a bidirectional manner.6-9 At present, large evidence base suggests that diabetes is associated with an increased prevalence, extent and severity of gingivitis and periodontitis.10

In 2005, approximately 177 million people worldwide have diabetes mellitus, and this number may double by the year 2030. American Diabetes Association (ADA) has added periodontal disease as the 6th complication of diabetes.11,12 India ranks first in the highest numbers of people with diabetes in 2000 with 31.7 million people and it is estimated that by 2030 the diabetic patients in the nation may go up to 79.4 million.13 Diabetes mellitus is one of the most frequent metabolic disorders with an estimated prevalence of 7% in industrialized countries, of which nearly half the cases are undiagnosed.14,15

The conventional laboratory methods that are employed to screen for diabetes are time consuming and necessitates elaborate equipments. The advent of blood glucose monitors allows the clinicians to assess blood glucose levels at the chairside and results are obtained instantaneously in contrast to laboratory methods. This present study is indented to estimate the blood glucose levels from gingival crevicular blood so that a noninvasive chairside estimation of blood glucose levels could be done. The blood glucose monitoring system used in this study is accu-chek Go (Roche diagnostics) which works on the principle of electrochemical methodologies. These monitors quantify glucose amperometrically by measuring the current that is produced when glucose oxidase catalyzes the oxidation of glucose to gluconic acid or when glucose dehydrogenase catalyzes the oxidation of glucose to gluconolactone. The electrons generated during this reaction are transferred from the blood to the electrodes. The magnitude of the resultant current is proportional to the concentration of glucose in the specimen and is converted to a readout displayed on the monitor.

MATERIALS AND METHODS

The study was carried out in the Department of Oral Medicine, Diagnosis and Radiology, Sree Balaji Dental College and Hospital, Chennai. Ethical clearance was obtained for the study and a written informed consent was obtained from every patient before performing the test.
A total of 100 patients with chronic periodontitis of age group between 29 and 75 years were taken for the study. They were divided into two groups, groups I and II. Group I comprised of diabetic patients and group II comprised of age and sex matched controls. OPG was taken for both the groups to check the status of periodontitis.

Patients were selected based on the following criteria:
1. Patients with known history of diabetes and non-diabetic patients with generalized chronic periodontitis diagnosed clinically with presence of periodontal pockets and radiographically with bone loss were selected.
2. Patients with the history of bleeding disorders, patients on anticoagulant therapy, NSAIDs and ascorbic acid medications and pregnant patients were excluded from the study.

GLUCOSE MEASUREMENT

Gingival Crevicular Blood
As maxillary anterior teeth offer an ideal access for the collection of gingival crevicular blood (GCB), the GCB from either of the maxillary central incisors were taken for estimation of blood glucose levels. For each measurement, only one site with bleeding on probing was selected. Sites with suppuration were excluded from the study. After selecting the bleeding site, the site was isolated with cotton rolls. The interdental papilla between the central incisors was probed with Williams probe. As soon as the probe was removed, the gingival crevice was observed for bleeding. At this stage, the test end of the strip (mounted on the glucose monitoring device already) was kept on to the bleeding site to obtain the blood sample on the test strip without contacting the gingival or palatal tissues. The test strip was held until the instrument beeped giving the blood glucose measurements in mg/dl (Fig. 1).

Finger-prick Blood
The pulp of the finger was wiped with the surgical spirit and spirit was allowed to evaporate. The finger was then punctured with a sterile lancet. The first drop of blood was discarded and the second drop of blood was touched to the test end of the strip. It was held until the instrument gave a beep displaying the blood glucose measurements on the screen in mg/dl (Fig. 2).

Intravenous Blood
The flexor surface of the patient’s nondominant arm was wiped with spirit and the spirit was allowed to evaporate. Using a disposable syringe, 0.5 ml of venous blood was drawn from the antecubital fossa into the syringe and the blood sample was analyzed for the measurement of blood glucose levels using a reference glucose analyzer.

HEMATOCRIT MEASUREMENT
Blood collected was estimated for blood glucose levels using photometric calorimeter. Hematocrit (Hct) is the percentage of blood volume occupied by the red blood cells. This measurement was important because the glucose self-monitoring device measures whole blood glucose whereas reference glucose analyzer measures blood glucose in the remaining plasma after cell separation. To compare the measurements, hematocrit is used to correct the reference laboratory measurement for the concentrating effect on glucose due to loss of cell volume. Thus, the plasma measurement can be converted to whole blood measurement by the following formula:

Hct corrected venous glucose (mg/dl) = laboratory (mg/dl) × \[1.0 – (0.0024 \times \text{Hct})\].

As there is a natural physiological drop in the blood glucose concentration as it passes from a capillary (such as in the gingival crevice) area into a venous area due to normal cellular uptake of glucose, the measurements were corrected for direct comparison to the glucose self-monitor readings.
by addition of 3.5 mg/dl (average drop being 2 to 5 mg/dl) to the above formula:

Corrected venous glucose = laboratory (mg/dl) × [1.0 – (0.0024 × Hct)] + 3.5 mg/dl.

RESULTS

Descriptive data are presented as mean ± SD and range values (Table 1). The difference between the measurements in the same individual was tested by paired ‘t’ test. Pearson’s correlation coefficient was used to assess the relationship between different measurements (Table 2).

- **Group I**: A statistically significant correlation (p-value <0.001) was found between GCB and FP (r-value = 0.969), GCB and IVB (r = 0.964) and FPB and IVB (r = 0.990) (Graphs 1 to 3).

- **Group II**: A statistically significant correlation (p-value <0.001) was found between GCB and FP (r-value = 0.569), GCB and IVB (r = 0.579) and FPB and IVB (r = 0.742).

DISCUSSION

The close interrelationship between diabetes and periodontitis can be assumed that the dental practitioner is extremely likely to encounter an increasing number of undiagnosed diabetes patients with periodontitis. Type 2 diabetes mellitus constitutes nearly 90% of population in any country. It has been estimated that about one-third of type 2 diabetes mellitus cases are undiagnosed and its incidence has been increased by up to 6% per year. The early diagnosis of diabetes, however, might help to prevent its long-term complications that are responsible for the high morbidity and mortality of diabetic patients.

Since, periodontal inflammation with or without complication factor of DM is known to produce ample extravasation of blood during examination, no extra-procedure, e.g finger puncture with sharp lancet is necessary to obtain blood for glucometric analysis. Even in case of very low gingival crevicular bleeding, glucose measurement is possible with the use of self-monitoring device due to the low amount of blood necessary to perform the analysis. Dentist seems to be more secure in obtaining blood samples from gingival tissues than using conventional blood collection methods.

**Group I: Diabetic patients with chronic periodontitis:**

On comparison between gingival crevicular blood glucose measurements, finger-prick blood glucose measurements and corrected intravenous blood glucose measurements, a very strong correlation was seen with an r-value of 0.99, which was statistically highly significant (p-level <0.001), respectively. The results of this study are in agreement with the studies conducted by Parker et al in 1993, who examined diabetic patients with unknown periodontal status, and where in a very strong correlation was observed between gingival crevicular, finger prick capillary and the corrected intravenous blood glucose measurements.

**Group II: Nondiabetic patients with chronic periodontitis:**

The comparative results of finger-prick blood and corrected intravenous blood, and, gingival crevicular blood and intravenous blood glucose measurements showed a strong correlation in the present study. Hussian 2010 showed strong correlation between FPB and IVB and GCB and IVB among nondiabetic patients.

This is in agreement with Beikler T et al 2002, Strauss SM et al and Ardakani MR et al wherein, a strong correlation was observed between GCB and finger stick

<table>
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<th>Groups</th>
<th>No.</th>
<th>Particular</th>
<th>GCB (mg/dl)</th>
<th>FPB (mg/dl)</th>
<th>Corrected IVB (mg/dl)</th>
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capillary measured blood glucose when diabetic and non-diabetic patients with moderate to advanced periodontitis were examined.

CONCLUSION

Within the limitations of this study, it is concluded that gingival crevicular blood (GCB) collected during examination is an excellent source of blood for glucometric analysis. The technique is safe, easy to perform, and comfortable for the patient and therefore, helps to increase the frequency of diagnosing diabetes and provides a more objective indicator for referral to physicians. Thus, the dentist may play a vital role as a member of the health team by participating in the search for undiagnosed asymptomatic DM.

REFERENCES


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