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ORIGINAL RESEARCH

Noninvasive Technique for Estimating Blood Glucose Levels among Diabetic Patients

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ABSTRACT

Aim: The present study was aimed to assess the fasting and postprandial gingival crevicular blood (GCB) glucose and finger stick blood glucose measurements using a glucometer.

Materials and methods: A total of 30 subjects with periodontitis and positive bleeding on probing were considered. Subjects were instructed to report to the department after overnight fasting. Gingival crevicular blood samples were collected from anterior region showing bleeding on probing followed by finger stick blood sample collection. Then, the patients were instructed to take 75 gm of glucose and after 2 hours blood samples from two sites were collected similarly. Results were analyzed using unpaired t test and Pearson's correlation.

Results: Mean glucose levels form GCB and finger stick blood did not differ either during fasting or postprandial ($p > 0.05$). Significant correlation was found between GCB glucose levels and capillary finger stick blood (CFB) glucose levels during fasting ($r = 0.946$, $p < 0.001$) and postprandial ($r = 0.930$, $p < 0.001$) blood estimation.

Conclusion: Periodontal probing can be considered as an alternate noninvasive method of blood glucose estimation for screening of diabetes mellitus (DM). The technique described is safe, easy to perform, and helps to increase the frequency of diabetes screening in dental office.

Clinical significance: The GCB from probing can be a good source of blood for estimating blood glucose levels and screening for diabetes using portable glucose monitors. Also, it will be a simple and relatively inexpensive in office screening procedure for any patient suspected to have diabetes.

Keywords: Blood glucose, Capillary finger stick, Diabetes mellitus, Gingival crevicular blood.

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INTRODUCTION

Diabetes mellitus (DM) is undiagnosed in approximately half of the patients actually suffering from the disease,[1] as DM is asymptomatic in its early stage and can remain undiagnosed for many years.

The early detection of subclinical disease by advanced screening procedures is making considerable progress in the field of preventive medicine to reduce the nonstop progression of certain chronic diseases. The field of periodontal medicine can also help in early detection of certain chronic systemic diseases such as DM in an easier and simplified manner.[2]

Considerable effort has been made in the past few years to develop painless and noninvasive methods to measure blood glucose,[3] and as a result, today there are plenty of blood glucose estimation devices that are available in the market. These devices are more sensitive,

self-monitoring, developed for testing small amounts (<2 µl) of blood, and the accuracy of these glucometers has been acceptable.[4] Also, these devices are used even by diabetic and nondiabetic subjects routinely at home. But to use those devices, a finger-puncture with a sharp lancet is required, which is an invasive and painful procedure.

Bleeding from gums is an objective symptom of gingival inflammation and a first sign of periodontal disease. Diabetes and periodontitis seem to interact in a bidirectional manner.[5] The increased prevalence and severity of periodontitis seen in patients with diabetes, especially those with poor metabolic control, has led to the designation of periodontal disease as the "sixth complication of diabetes."[6]

Dentist routinely probe gingival tissue in order to identify gingival inflammation and periodontal pockets. During this routine procedure, blood oozing from the gingival crevices of patients with periodontal problem and gingival inflammation is common phenomenon and this entire procedure is noninvasive to perform.

Extravasated blood during routine dental diagnostic procedures could be a simple and relatively inexpensive in office screening device for any patient suspected to have diabetes. Also, they can be used to monitor blood glucose levels in known diabetic individuals.[7]

As periodontal inflammation with or without the complicating factor of DM is known to produce ample extravasated blood during diagnostic procedures.[8] Routine probing during periodontal examination is more familiar to the dental practitioner and is less traumatic than a finger puncture with a sharp lancet. Hence, gingival crevicular blood (GCB) from probing can be a good source of blood for estimating blood glucose levels and screening for diabetes using portable glucose monitors. Also, it will be a simple and relatively inexpensive in office screening procedure for any patient suspected to have diabetes. Hence, the present study was designed to estimate and correlate capillary blood glucose and GCB glucose levels among subjects with or without diabetes.

OBJECTIVES

The aim of this study are:

- To assess fasting and postprandial blood glucose from GCB among subjects with periodontitis
- To assess fasting and postprandial blood glucose level by using capillary finger stick blood (CFB) among subjects with periodontitis
- To compare and correlate the conclusions drawn by GCB and CFB for glucose estimation.

MATERIALS AND METHODS

The present study was a cross-sectional study carried out in the Department of Oral Pathology and Microbiology at Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat. Subjects for the study were recruited from the Department of Periodontics and Implantology at Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat.

Selection of Study Subjects

Inclusion Criteria

- Patients 30 to 60 years of age
- Subjects with moderate to periodontitis with and without Type II DM
- Subjects with at least two teeth in the maxillary anterior region showing bleeding upon probing.

Exclusion Criteria

- Subjects undergoing treatment for anemia, polycythemia, gout, dialysis, or any other disorder that could cause an abnormal variation in the hematocrit were excluded.
- Subjects on medication who interfered with coagulation (e.g., analgesics, anticoagulants) or supplemental Vitamin C that could interfere with the glucose test strip oxidation reaction will also be excluded.
- Subjects with active smoking history.
- Subjects giving a history of alcohol use before 24 hours of sample collection.

Methodology

Only those patients who gave a signed informed consent were included in the study. The subjects who fulfilled the study criteria were asked to come in the morning after fasting overnight. Patient's general and detailed medical, family, and personal history was recorded and the clinical examination was performed. A specially designed proforma was used collect data.

The gingiva around the upper anterior teeth was chosen as the donor site for the GCB sample. Supra and subgingival scaling was carried out to help facilitate collection of the blood. Contamination with saliva was minimized by using cotton roll and suction tip and air-drying to prevent contamination with saliva.

Maxillary anterior teeth were probed with a William's periodontal probe, with a force of approximately 0.2 N. Bleeding on probing was assessed during 30 to 60s after probing. Sites with profuse bleeding were preferred as donor sites, while sites with suppurations were avoided. To obtain a clean sample, probing was repeated when necessary, until a sufficient quantity of blood (2–3 µl) is present to gather a sample. The blood was collected with

the help of a small glass capillary tube of 2 mm bore and transferred on to a test strip.

Then, the regular CFB was collected from one of the patient's fingers. The pad of the finger was wiped with alcohol allowed to dry and then punctured with a sterile lancet. The blood was drawn onto the test strip preloaded in the glucometer. Both samples from each individual were taken at the same visit. Results were recorded and tabulated for each subjects separately.

The blood from two selected areas was analyzed using the glucose self-monitoring device (ACCU-CHEK Active, Roche Diagnostics, USA) according to the manufacturer's instructions.

Then, the patients were instructed to take 75 gm of glucose, and after 2 hours, again, the same procedure was repeated to perform postprandial (PP) blood sugar test from the gingiva and finger.

Statistical Analysis

Statistical analysis was done using Statistical Package of Social Sciences (SPSS) version 17). Analysis of the obtained results was carried out by two using Student's t test to test the significant difference between the two readings and correlation was evaluated using Karl Pearson's correlation test. Data were analyzed at 95% confidence interval and a p-value less than 0.05 was considered as statistically significant difference.

RESULTS

Table 1 summarizes distribution of study subjects according to age and gender; the mean age of males was 42.86 ± 11.32 years and females was 44.00 ± 2.97 years. Age wise, there was no difference between the genders.

Table 1: The distribution of study subjects according to age and gender

Gender	*Mean age*	*SD*	*t*	*p and significance*
Males (15)	42.86	11.32	0.375	0.711
Females (15)	44.00	2.97		NS

NS: Nonsignificant; p < 0.05.

Table 2: Mean and standard deviation of fasting gingival crevicular blood glucose and fasting capillary finger prick blood glucose levels among study subjects

Blood glucose	*Mean*	*SD*	*t*	*p and significance*
Capillary finger prick blood glucose	109.96	17.83	0.230	0.819
Gingival crevicular blood glucose	110.93	14.60		NS

NS: Nonsignificant; p < 0.05

Table 3: Mean and standard deviation of postprandial gingival crevicular blood glucose and postprandial capillary finger prick blood glucose levels among study subjects

Blood glucose	*Mean*	*SD*	*t*	*p and significance*
Capillary finger prick blood glucose	158.10	20.73	1.043	0.301
Gingival crevicular blood glucose	163.30	17.75		NS

NS: nonsignificant; p < 0.05

Table 2 summarizes the mean and standard deviation (SD) of fasting GCB glucose (109.96 ± 17.83) and fasting capillary finger prick blood glucose (110.93 ± 14.60) levels among study subjects; an unpaired t test revealed no difference in the mean glucose levels from two sites.

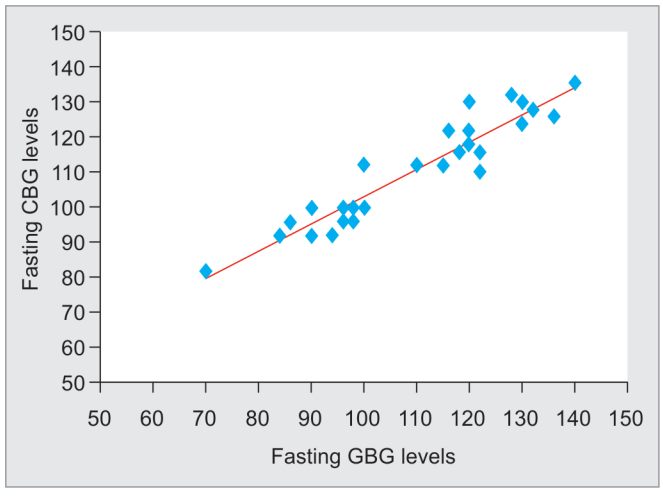
Table 3 summarizes the mean and SD of postprandial GCB glucose (158.10 ± 20.73) and postprandial capillary finger prick blood glucose (163.30 ± 17.75) levels among study subjects; an unpaired t test revealed no difference in the mean glucose levels from two sites.

Table 4, Graphs 1 and 2 show Pearson's correlation for fasting and postprandial GCB glucose and fasting CFB glucose. There was a highly significant correlation among GCB and CFG with r = 0.946 and 0.930 respectively.

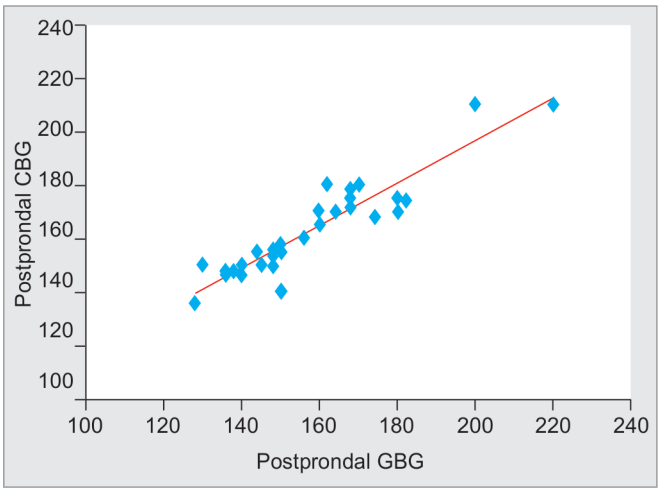
Table 4: Pearson's correlation for fasting gingival crevicular blood glucose and fasting capillary finger prick blood glucose

Pearson's correlation	*r*	*p and significance*
Fasting gingival crevicular blood glucose *vs* fasting capillary finger prick blood glucose	0.946	0.000*
Postprandial gingival crevicular blood glucose *vs* postprandial capillary finger prick blood glucose	0.930	0.000*

p < 0.05 *Highly significant



Graph 1: Fasting CBG and GBG (Crevicular blood) levels among study subjects



Graph 2: Postprondal CBG and GBG (Crevicular blood) levels among study subjects

DISCUSSION

Studies have proved that there is close interrelationship between diabetes and periodontitis.[8] Also, it is not un-common for many dental practitioners to encounter an increasing number of undiagnosed diabetes patients with periodontitis. 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.

Adequate quantity of blood necessary for glucose estimation is extravasated from the gingival crevice during routine periodontal examination in dental clinics. With regard to the early detection of DM in the present study, we utilized that this extravasated blood from the gingival crevice is an easy and quick method for screening DM.

Chair-side method of diabetic screening with gingival blood was first described by Stein and Nebbia.[2] They transferred blood onto the test strip by wiping blood directly from hemorrhagic gingival tissue.

Parker et al[3] in 1993 reported that direct wiping of intraoral blood on to the test strip will not produce a uniformly timed reaction and may damage the strip's chemical indicator surface and are significant sources of error when using glucose self-monitors.

To overcome these errors, Parker et al[3] used a glucometer, which is self-timing and requires no wiping. The use of plastic pipette is claimed to reduce contamination of the sample with saliva, plaque, and debris. Hence, in the present study, we used a glass capillary tube of 2 mm bore and transferred on to a test strip.

It has been reported that the free glucose concentration in gingival fluid was influenced by local environmental factors such as the microflora and the liberation and activation of hydrolyzing enzymes.[3] Thus, GCB after probing may not represent true capillary blood glucose measurement. In our study, after proper isolation and drying of the site, sample was collected from the outer surface of the gingiva, thus eliminating the possibility of contamination with crevicular fluid.

In the present study, ACCU-CHEK Active® glucometer was used because it is the most widely used glucometer and easy-to-learn and easy-to-use with intuitive icons and simple two-button navigation gives fast and accurate results: The meter requires no more than 5 seconds to measure and delivers results.[9]

The present study both fasting and postprandial blood glucose measured from GCB and CBG showed positive correlation with r = 0.946 and 0.930 respectively; this is in accordance with the studies by Parker et al[3]and Beikler et al[10] who also reported a strong correlation between blood glucose measured in GCB and CFB when diabetic and nondiabetic subjects were examined.

Sarlati et al[11] in 2010 reported that GCB is useful for testing blood glucose during routine dental examination in subjects with DM and periodontitis but not in those without DM, which is in contrast to the present study wherein irrespective of diabetic status among subjects there was a highly positive correlation.

The mean blood glucose levels measured form GCB and CFB during fasting and postprandial times were nonsignificant with highly significant correlation value. This finding of the present study is consistent with the most of previous studies of Wu et al,[11] Ardakani et al,[12] Shetty et al,[13] and Strauss et al[14] on the correlation between gingival crevicular and capillary blood glucose levels who also reported that GCB samples are suitable to screen for DM in individuals with sufficient bleeding on probing (BOP).

Muller and Behbehani[15] in 2005 reported no correlation between GCB and CFB. The results of the present study revealed a higher correlation between GCB and CFB with a smaller sample size. Estimations of fasting and postprandial blood glucose levels were less frequently conducted. In the present study, both fasting and postprandial blood glucose levels showed correlations with capillary blood glucose levels, thereby suggesting that testing crevicular blood may be a valuable tool in identifying potential patients with diabetes.

None of the subjects under study reported pain/discomfort and no complications have been reported after sampling by this method.

CONCLUSION

This screening study clearly pointed out the importance of the early detection of diabetes in a population that composed of patients predominantly having gingival and

periodontal diseases, thus developing a safe, rapid, and noninvasive approach to screen diabetes.

The technique of using GCB is less traumatic and less time-consuming and does not cause any discomfort to the patient motivating the dental professionals to implement diabetes screening using a GCB sample and feel comfortable and confident in doing so.

The successful resolution of periodontal inflammation results in the stabilization of blood glucose. Therefore, multiple measurements of a diabetic patient's blood glucose allow the dentist to better assess the patient's diabetic control as treatment progresses and success in the periodontal therapy with decreased gingival blood glucose level.

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