ORIGINAL RESEARCH

Comparison of Gingival Crevicular and Capillary Finger-prick Blood in the Blood Glucose Levels Assessment of Gingivitis and Periodontitis Patients

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Abstract

Aim: The aim of this study is to determine the blood glucose levels from gingival crevicular bleeding during routine periodontal examination and to compare its accuracy with finger-prick blood (FPB) using a self-monitoring device during routine dental visits.

Materials and methods: A total sample size of *n* = 80 with group I (gingivitis; *n* = 40) and group II (periodontitis; *n* = 40) subjects were included in this study. On periodontal examination, gingival crevicular blood (GCB) was collected and simultaneously FPB was collected from the same patient. A quantity of 2 µL blood from both were analyzed by self-monitoring glucometer (Accu-Chek Active). Results were obtained and statistically analyzed using SPSS software.

Result: The mean GCB and FPB glucose levels were 50.98 ± 31.538 and 94.28 ± 41.464, respectively in gingivitis group whereas the mean GCB and FPB were 89.38 ± 46.022 and 160.80 ± 77.761, respectively in periodontitis group. Both the groups suggested a strong positive correlation, where r = 0.924 in gingivitis group and r = 0.808 in periodontitis group.

Conclusion: The results from this current study show that GCB collected during diagnostic periodontal examination may also be a reliable source of blood for glucometeric analysis. The glucose levels of crevicular blood can also be a potential risk factor to alter the oral microflora favoring dysbiosis which may lead to the progression of periodontitis.

Clinical significance: Diabetes and periodontitis being interlinked with each other influence the oral health and its related treatment. This emphasizes mandatory evaluation of blood glucose levels during regular dental screening. This study evaluates the GCB oozing during periodontal examination that can serve as an alternative source of blood for glucose evaluation, being less traumatic and noninvasive than FPB.

Keywords: Diabetes, Finger-prick blood, Gingival crevicular blood, Glucose, Periodontitis.

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Introduction

Diabetes mellitus is a systemic disorder which is caused due to metabolic dysregulation primarily because of carbohydrate metabolism characterized by hyperglycemia (blood glucose >180–200 mg/dL) that results from defects in insulin secretion or impaired insulin action or both. Alterations in lipid and protein metabolism were also seen. Chronic elevation in blood glucose is associated with long-term dysfunction of various organs such as eyes, kidneys, heart, nerves, and blood vessels.[1] People with undiagnosed diabetes are likely to have diabetes for several years leading to an altered beta-cell function before even being diagnosed. Diabetes mellitus is also associated with long-term complications such as retinopathy, nephropathy, neuropathy, micro- and macrovascular diseases, altered wound healing, and periodontitis.[2] The earlier diagnosis of diabetes may help to prevent the long-term complications that are responsible for its high morbidity rate.[3]

Periodontitis being a known complication of diabetes, is an inflammatory disease of the supporting tissue of the teeth caused by specific microorganism resulting in progressive destruction of the periodontal ligament and the alveolar bone with pocket formation, recession, or both. As a part of inflammation of periodontium, gingival crevicular bleeding on probing is a common clinical finding of periodontitis. Gingival crevicular bleeding occurs as a result of vasodilation and engorgement of blood vessels and ulcerated epithelium which bleeds spontaneously on probing. Periodontitis is influenced by various risk factors like smoking, systemic disease, stress, etc. Though the risk factors include various systemic diseases, diabetes is considered as one of the major risk factors associated with periodontitis. Literature suggests that poor glycemic control may cause high prevalence of gingival inflammation, periodontal destruction, and *vice versa*.[4] This is attributed due to the advanced glycation end products (AGEs) that bind to its receptors in the macrophages and releases inflammatory cytokines. The TNF-alpha and IL1-beta produced release hydrolase, matrix metalloprotienase (MMP), and collagenase thereby leading to destruction of connective tissue and periodontal disease.[2]

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Thus, American Dental Association stated that periodontitis is considered as the "sixth complication" of diabetes.[5]

Diabetes and periodontitis being interlinked with each other directly or indirectly influence the oral health and its related treatment.[6] Therefore, it is mandatory to evaluate the patient for diabetes on their initial dental visit especially, when patient is diagnosed with periodontitis. Patient being either known or unknown diabetic, FPB is usually used for diabetes evaluation, similarly, gingival bleeding on probing is a common indicator for the evaluation of periodontitis. The crevicular blood not only reflects as a clinical marker of the periodontal disease, but as well serves as a diagnostic tool to evaluate multiple biological markers. Thus, the current study proposes and evaluates the use and authenticity of this GCB collected during periodontal examination, as a potential alternative for FPB in evaluating the glucose levels during dental visits. Additionally, it is found to be less traumatic, noninvasive, less time-consuming, and simple technique than a finger prick with a sharp lancet comparatively.[7]

Aim

The aim of this study is to determine the blood glucose levels from gingival crevicular bleeding during routine periodontal examination and to compare its efficacy with FPB using a self-monitoring device.

Materials and Methods

A total of 140 patients were recruited from the outpatient at Department of Periodontics, Priyadarshini Dental College and Hospital, Chennai, Tamil Nadu and assessed for eligibility in the study. Out of 140, 22 patients were not interested to participate in the study and 38 patients were excluded due to presence of other systemic diseases. The power analysis and confidence interval of the study were calculated to be 90 and 95% with 40 patients in each group (group I—gingivitis; group II—periodontitis), respectively.[8] The study population is schematically represented in Figure 1. Ethical committee approval (PDCH/EC2123) was obtained. Informed consent was obtained from all the participants of the study. Routine periodontal examination was done and categorized as group I (gingivitis; $n = 40$) and group II (periodontitis; $n = 40$). The inclusion criteria for the groups I and II were based on Classification of Periodontal Diseases, World Workshop on Periodontology, 2017.[9]

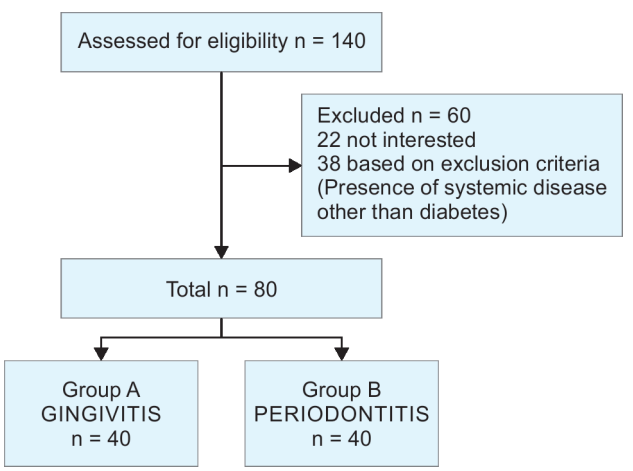


Fig. 1: Study population

Inclusion criteria:

- Age-group from 20–60 years.
- Dentition with minimum 10 natural teeth.
- Group I: Presence of gingival inflammation with probing pocket depth (PPD) ≤3 mm and bleeding on probing >10%.
- Group II: Presence of interdental clinical attachment loss (CAL) ≥2 nonadjacent teeth, or buccal CAL ≥3 mm with pocketing >3 mm is detectable at ≥2 teeth.

Exclusion criteria:

- Patients who have undergone antibiotic therapy during the past 6 months.
- Any other systemic disease other than diabetes.
- Blood dyscrasias and immunodeficiency disorders.
- Periodontal therapy for past 6 months.

Collection of GCB

The periodontal examination was done by two trained and calibrated investigators (VVA and IP). The calibration was done before the start of the study using 10 periodontitis patients who were not part of this study. K-statistics were done to check inter and intraexaminer reliability. The average k-value was seen to be 0.84 and 0.79, respectively, which is considered as satisfactory. The periodontal examination was done using William's periodontal probe. Routine periodontal examination such as gingival index, oral hygiene index, PPD, clinical attachment levels, and Russel's periodontal index were done. The measurements were recorded to the nearest millimeter. The site of anterior and posterior teeth was isolated with cotton rolls to prevent saliva contamination.[8] On periodontal probing, bleeding was observed and the blood oozed from the respective gingival crevices was collected using the end of the strip and then assessed for glucose reading with a self-monitoring glucometer (Accu-Chek Active).[10] Accu-Chek Active was chosen in this study, as its sensitivity and specificity are 83.3 and 96.3%, respectively. It is also shown to have least variation from the laboratory results.[11]

Collection of FPB

Capillary FPB was collected from the index finger of the same patient to assess blood glucose level. The pad of the finger was initially wiped with alcohol swab, which was then allowed to dry and then punctured with a sterile lancet. This blood sample was then transferred to the test strip.

Both the FPB and GCB were collected as random blood sugar evaluation because they were taken regardless of the patient's last mealtime.[12]

Statistical Analysis

Statistical analysis was done by SPSS software version 17. Descriptive statistics were presented as numbers and percentages. Mean ± standard deviation for all the parameters (demographic, periodontal, and glucose levels) were estimated for both the groups and the level of significance was determined. To find the significant differences between both the groups, independent sample test was used for continuous variables [age, habits, oral hygiene index (OHI), gingival index (GI), Russell's periodontal index (RPI), PPD, CAL]. Pearson's correlation coefficient was found to assess the relationship between the glucose levels (FPB and GCB) in both the groups.

Results

Table 1 shows the demographic details of the study subjects. Group I and group II showed a mean age of 26.68 ± 8.25 and 47.95 ± 12.27, respectively with a significant difference. There were no significant differences seen in sex and smoking among both the groups, showing equal distribution of both the sex and equivalent prevalence of smokers in both the groups.

Table 2 shows the mean clinical periodontal parameters such as oral hygiene index score (OHI-S) (group I—1.840 ± 0.4695; group II—2.762 ± 0.6838), gingival index score (GI-S) (group I—1.015 ± 0.0802; group II—1.403 ± 0.3779), Russell's periodontal index score (RPI-S) (group I—2.098 ± 0.1527; group II—3.030 ± 0.8118), PPD (group I—3.072 ± 0.1132; group II—3.388 ± 0.5598), and CAL (group I—3.015 ± 0.0427; group II—3.253 ± 0.2219). On comparison of both the groups, there was a phenomenal significant difference (p-value ≤ 0.001) among the groups with respect to OHI-S, GI-S, RPI-S, PPD, and CAL confronting the fact of group I being gingivitis and group II being periodontitis.

Table 3 shows the Pearson's correlation for FPB and GCB. The correlation coefficient (r) in both the groups showed a strong positive correlation between glucose levels of GCB and FPB with the values of 0.924 in gingivitis group and 0.808 in periodontitis group, respectively with p-value of 0.000 in both the groups. Thus, 92% positive correlation (r = 0.924) in group I and 80% positive correlation (r = 0.808) in group II were seen. The correlation between glucose levels of gingivitis and periodontitis subjects of this study is pictorially represented as scatter graph in Figures 2 and 3, respectively.

Discussion

Periodontitis and diabetes being bidirectionally interrelated, and the fact of periodontitis being the sixth complication of diabetes, validates the importance and urges the mandatory assessment of blood glucose levels in known diabetics as well as undiagnosed diabetic patients prior to periodontal therapy. Most common method of blood sugar evaluation being finger prick or laboratory testing is invasive, traumatic, expensive, and time-consuming. This emphasizes to check the feasibility of the GCB obtained during routine periodontal examination as a source of blood for evaluation of blood glucose levels, as GCB is noninvasive, atraumatic, easy procurement and comfortable to the patient, and obtained free of cost during dental screening. The current study consisted of total 80 subjects with 40 subjects in each group based on inclusion and exclusion criteria. Demographic details, periodontal parameters, and blood glucose levels with GCB and FPB were assessed for both the groups.

Table 1 suggests the demographic variables with significant difference in age and no significant difference in gender and smoking among both the groups. The age was found to be significantly higher in periodontitis group (group II) than gingivitis group (group I). This clearly implies age to be one of the confounding factors for periodontitis. Our study showed similar results to that of study conducted by Ilango et al. suggesting that periodontal destruction is positively correlated with age.[13] The increased periodontal destruction with age can be attributed to increased time of exposure of periodontal tissues to local factors and periodontal pathogens.

Table 2 represents all the periodontal parameters such as OHI, GI, RPI, PPD, and CAL showing statistically significant difference between the groups (p-value of 0.000 for OHI, GI, RPI, CAL, and 0.001 for PPD) suggesting the severity of periodontal destruction in group II (periodontitis) compared to group I (gingivitis). Our findings were similar to the literature evidence of Bhardwaj et al. suggesting that periodontal parameters vary significantly different among healthy gingivitis and periodontitis groups based on periodontal involvement.[14] Over the years, till date, FPB or intravenous blood was considered as standard source of blood for glucose evaluation. With recent literature of GCB as screening tool for blood glucose evaluation, our study assesses the efficacy of GCB, oozed during periodontal screening in gingivitis and periodontitis group, to be used as an alternative source of blood for glucose evaluation. As patients report for periodontal screening regardless of the last mealtime, evaluation of random blood sugar levels was done in both FPB and GCB, irrespective of fasting or postprandial state of meal.[12]

Parker et al. in 1993 examined 50 diabetic patients with unknown periodontal status and concluded evident relationship between gingival crevicular, finger-prick capillary, and intravenous

Table 1: Demographic details of the study groups

Parameters	*Group I—gingivitis (Mean ± standard deviation)*	*Group II—periodontitis (Mean ± standard deviation)*	*p-value*
Age	26.68 ± 8.251	47.95 ± 12.270	0.000*
Sex	Male, 27 (67.5%) Female, 13 (32.5%)	Male, 23 (57.5%) Female, 17 (42.5%)	0.356
Habits (smoking)	3 (7.5%)	11 (27.5%)	0.019

*Statistical significance

Table 2: Mean ± standard deviation for periodontal parameters in group I and group II

Parameters	*Group I—gingivitis (Mean ± standard deviation)*	*Group II—periodontitis (Mean ± standard deviation)*	*p-value*
OHI-S	1.840 ± 0.4695	2.762 ± 0.6838	0.000*
GI-S	1.015 ± 0.0802	1.403 ± 0.3779	0.000*
RPI-S	2.098 ± 0.1527	3.030 ± 0.8118	0.000*
PPD (in mm)	3.072 ± 0.1132	3.388 ± 0.5598	0.001*
CAL (in mm)	3.015 ± 0.0427	3.253 ± 0.2219	0.000*

*Statistical significance

blood glucose measurements.[15] Beikler et al. in 2002 examined diabetic and nondiabetic patients with moderate to advanced periodontitis and suggested a significant correlation (r = 0.98) between GCB and finger-stick capillary blood glucose.[10] Dwivedi et al. in 2014 also implied similar results (*p*-value = 0.001) between GCB and FPB in 75 subjects with chronic periodontitis.[16]

A study by Kandwal et al., contrarily showed a weak positive correlation comparing FPB and GCB with (r) +0.045 and −0.0324 in diabetic and nondiabetic subjects, respectively suggesting GCB values to be higher than FPB.[16] The reason suggested for the reversed increase was due to the presence of glucose as a constituent in the GCF, which may increase the overall blood glucose.[17]

Considering the various evidences gathered from the literature, there was a contradicting study lacking correlation between GCB and FPB, and few studies suggesting positive correlation which were irrespective of periodontal involvement. Our study is the first of its kind to evaluate the efficacy of GCB to that of FPB based on periodontal involvement (gingivitis and periodontitis) thereby assessing the influence of periodontal status affecting the glucose levels. Our results showed a strong positive correlation between GCB and FPB (r = 0.924) in gingivitis group and (r = 0.808) in periodontitis group as represented in Table 3.

Additionally, as seen in Table 3, comparatively higher glucose levels is seen in periodontitis group than gingivitis group in both GCB and FPB method, irrespective of source of collection, emphasizing the fact of periodontitis and diabetes interrelated bidirectionally and influences one another. In our study, invariably, increased glucose levels influence and affect the periodontal status. This could be due to the fact that increased glucose levels in GCB lead to alteration in the composition of the microbiome which in turn shifts the gram-positive aerobes to gram-negative anaerobes. This microbial shift could be because of a decrease in the number of beneficial symbionts and an increase in the number of pathobionts. Recent researches have indicated that dysbiosis in oral cavity due to increased level of glucose in the GCB can lead to periodontitis.[18] This may be the reason for statistical significance of glucose levels in periodontitis group than gingivitis group in the current study. Thus, GCB may not only be used as a screening tool for diabetes, but it can also be used to assess the periodontal status.

Few limitations of the study may include (a) the strip test method to evaluate the blood glucose that has less standardization compared to laboratory analysis of intravenous blood glucose tolerance testing, (b) the history of known and unknown diabetics not being assessed, (c) contamination of GCF that dilutes the glucose concentration, and (d) random assessment of blood sugar levels, which could be the reason the GCB values lesser than FPB despite of significance.[19]

To conclude, the present study indicates that GCB collected during the periodontal examination is a reliable source for glucose analysis during routine dental visits. It is more comfortable, safe, and less time-consuming for both patient and dentist than finger-prick technique. It is a more objective indicator for referral to physicians than traditional methods, thereby increasing the frequency of diagnosing diabetes during routine periodontal screening. Thus, it not only helps to assess the periodontal evaluation, but may also evaluate the systemic health of patient emphasizing perio-systemic interrelationship.

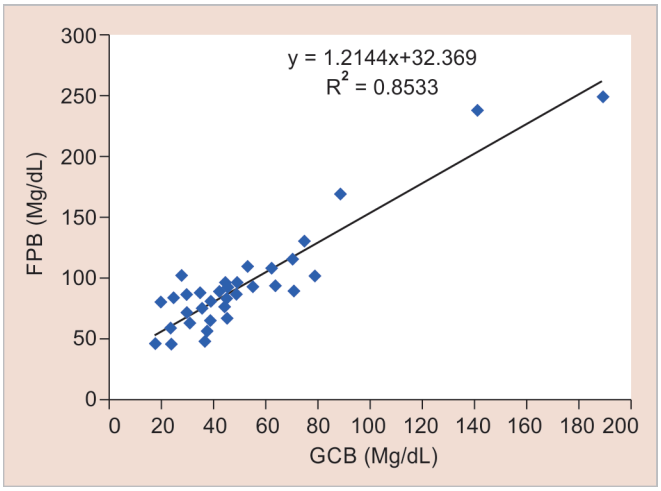


Fig. 2: Scatter plot graph between GCF and FPB in group I

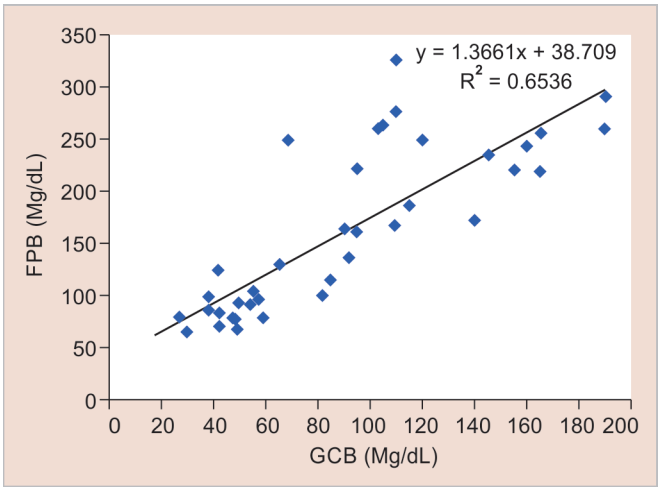


Fig. 3: Scatter plot graph between GCF and FPB in group II

Table 3: Pearson's correlation for glucose levels in group I and group II

Group	*FPB (mg/dL) (Mean ± standard deviation)*	*GCB (mg/dL) (Mean ± standard deviation)*	*Correlation (r value)*	*p-value*
Group I	94.28 ± 41.464	50.98 ± 31.538	0.924**	0.000*
Group II	160.80 ± 77.761	89.38 ± 46.022	0.808**	0.000*

*Statistical significance; **correlation is significant at the 0.01 level (two-tailed)

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