Original Research

GINGIVAL BLOOD GLUCOSE ESTIMATION IN A PERIODONTAL POPULATION FOR SCREENING OF DIABETES MELLITUS: A CROSS SECTIONAL STUDY

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Abstract

Objective: To estimate gingival blood glucose and its comparison with the conventional blood glucose testing methods in a periodontal population for screening of diabetes mellitus.

Materials and Methods: From the sample, 150 eligible patients were selected. The subjects to be evaluated were divided into two groups: Group 1 with Gingivitis and Group 2 with Chronic Periodontitis. Samples of gingival crevicular blood (GCB) and finger – prick capillary blood (FCB) were obtained randomly from all patients. Paired t-test was done for intragroup comparisons and Independent t-test for intergroup comparisons. Spearman correlation (r) was done to know the correlation between capillary glucose and gingival glucose levels.

Results: Of the 150 subjects, 10 subjects were diagnosed as diabetic patients (3 in Group 1 & 7 in Group 2). There was a statistically significant difference present in the Plaque score and Gingival score with a p value (p value =0.004) of the diabetic group (having higher score than non-diabetic group). When GCB glucose measurements were compared with FCB glucose measurements in diabetic patients, a very strong positive correlation was seen, which was statistically highly significant (p value < 0.001).

Conclusion: Gingival crevicular blood collected during periodontal examination might be an alternative source for glucometric analysis, in patients exhibiting atleast one inflamed site with bleeding on probing for screening of Diabetes mellitus. A high degree of correlation in blood glucose estimation between Gingival Crevicular Blood & Finger Capillary Blood samples confirms the former to be another reliable source.

Key words: Blood glucose; Diabetes; Finger capillary blood; Gingival crevicular blood.

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INTRODUCTION

Periodontium is a complex and highly specialized pressure sensing system consisting of four tissues (cementum, periodontal ligament, alveolar bone and junctional and sulcular epithelia) supporting the teeth. Of these structures, periodontal ligament is a dynamic tissue with high rate of remodeling and turnover, which connects the teeth to alveolar bone. However, periodontium when exposed to noxious products of biofilm makes it prone to various periodontal diseases. Among these, periodontitis is defined as “an apical extension of gingival inflammation to involve the tissues supporting the tooth, including periodontal ligament and bone”.

Recent findings have strongly suggested that there is an association between Periodontal diseases and systemic conditions such as cardiovascular diseases, Diabetes mellitus(DM) and adverse pregnancy outcomes. Diabetes mellitus, in itself, is a complex disease involving multiple systems of the body and syndromes, which have glucose intolerance in common. It is associated with a wide range of complications, such as retinopathy, nephropathy, neuropathy, micro and macrovascular diseases, altered wound healing and periodontitis. Moreover, diabetes and periodontitis, seems to interact in a bidirectional manner. The incidence and severity of periodontitis is influenced in part by DM and the level of blood glucose control. Moreover, periodontal therapy might exert beneficial effects on diabetes control.

The WHO predicts that diabetes in Asia alone will rise by 90% in the next 20 years. It 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. In addition, recent data indicates that the incidence of the Type II Diabetes, maybe increasing by up to 6% per year.

It is estimated that among dental patients, for every patient with known diabetes there is one with undiagnosed DM. Among the various diagnostic tests available for diabetes, the oral glucose tolerance test and fasting plasma glucose test are more complex tests used for definitive diagnosis. The periodontists frequently manage diabetic patients using limited information about their blood glucose control. It’s the responsibility of dental practitioners to screen for undiagnosed cases which may influence dental treatment for the general well-being of their patients. Thus, monitoring their blood glucose during the office-visit may be a better alternative. Periodontal inflammation with or without the complicating factor of diabetes mellitus is known to produce ample extravasated blood during diagnostic procedures. Routine probing during periodontal examination is more familiar to the practitioner and less traumatic than a finger puncture. It is, thus, possible that gingival crevicular blood from probing may be an excellent source of blood for glucometric analysis using the technology of portable glucose monitors.

Glucose self-monitoring systems when utilized in a dental office could result in a more objective parameter for referral for diagnosis of diabetes mellitus. It could result in earlier treatment and possible minimization of serious complications. Development of an intra-oral blood sampling technique as opposed to the typically used finger site could make such
tests even more suitable for use by dental practitioners.\textsuperscript{5}

In previous studies, in-office screening of gingival blood glucose levels in known Diabetics \textsuperscript{14} and periodontitis patients\textsuperscript{11} has been evaluated. Blood from the gingival crevice after probing is generally a mixture of capillary blood and gingival crevicular fluid, an inflammatory exudate.\textsuperscript{17}

The main advantage is that only 3µl of blood is required. It allows for totally painless testing of blood with mild or moderate gingivitis or periodontitis. This might be of considerable interest to the dental practitioners since this glucometer, is accurate, simple and relatively inexpensive and can be used as an in-office screening device for any patient, suspected to have diabetes.\textsuperscript{17}

Particularly, in healthy situations glucose levels in gingival crevicular fluid are considerably lower than blood glucose levels. \textsuperscript{18} Thus the question may arise whether glucose level measured in blood samples obtained during periodontal examination are sufficiently related to glucose levels in capillary blood obtained from the finger prick. \textsuperscript{17} This study attempts to validate blood oozing from gingival crevice after bleeding on probing as a reliable source for blood glucose measurement.

MATERIALS & METHODS

The study was conducted at the Department of Periodontology and Oral Implantology, Maharaja Ganga Singh Dental College and Research Center with the approval of institutional ethical committee. A total of 225 patients were approached of which 150 eligible patients were randomly selected from the outpatient department of the college. Prior to the study, the design and purpose of the study was verbally explained to all the patients. A detailed performa was prepared about the purposes of the investigation and a written consent was procured from them before treatment.

CRITERIA FOR SELECTION OF PATIENTS

Male and female patients between 18-55 years of age were randomly selected from the outpatient list. Patients having more than 14 teeth and not less than 7 teeth in each arch were selected for this study. Patients who were with any known/diagnosed form of immunosuppressive disease and subjects on any medications (antioxidants, anti-inflammatory drugs and antibiotics in the previous six months) were excluded from the study.

Furthermore, patients who had a current or had undergone periodontal treatment in last 3 months were excluded from participation. Arthritis (Rheumatoid and Osteoarthritis), Past and present smokers and alcoholics as well as pregnant or lactating women, post-menopausal women were also excluded from the study.

DATA COLLECTION

A detailed case history was procured from all the patients and the record of the patients was maintained as per the attached Performa to have a systematic and methodical recording of all the information and observations. The intraoral clinical examination was done in a dental chair, under standard conditions of light, using a mouth mirror, explorer, graduated periodontal probe and tweezers. Clinical parameters such as gingival and plaque index, bleeding on probing, periodontal pocket depth and clinical attachment levels
were recorded by visual examination on the four surfaces of the tooth for each patient by a single examiner. Based upon the clinical parameters measured, the subjects to be evaluated were divided into two groups as Group 1: subjects with Gingivitis (i.e. the plaque induced bleeding on probing & without extension into the periodontal structure) and Group 2: Subjects with Chronic Periodontitis (i.e. Pocket probing depth ≥4mm).

**GINGIVAL CREVICULAR BLOOD (GCB):** Blood oozing from the gingival crevice, while routine periodontal probing, was used for glucose measurement with the glucose self-monitoring device. **FINGER-PRICK CAPILLARY BLOOD (FCB):** Regular finger prick capillary blood sample was used for glucose measurement with glucose self-monitoring device. Samples of gingival crevicular blood and finger –prick blood were obtained randomly from patients with Gingivitis & Chronic Periodontitis.

Data was analysed using SPSS version 23.0. Tests performed were Descriptive statistics, Paired t-test for intragroup comparisons and Independent t-test for intergroup comparisons. Descriptive statistics included frequency, mean±SD of the scale data and its measurements. Paired t test was used for intra group comparison. Spearman correlation (r) was done to know the correlation between capillary glucose and gingival glucose levels.

**RESULT**

The study included a total of 150 patients [90 (60%) males and 60 (40%) females], belonging to age group 18-55 Years. The subjects were divided into two groups as Group 1 (patients with gingivitis) & Group 2 (patients with periodontitis) on the basis of the clinical parameters including Bleeding on Probing & Clinical Attachment Loss. In Group 1, percentage of males & females was 58.88 and 41.12% respectively. Similarly, in Group 2, percentage of males & females was 61.66 and 38.34% respectively. Overall (Mean±SD) age of subjects was 33.52 ± 7.5 Mean±SD age of subjects with gingivitis was significantly (p= <0.001) lower than that of subjects with periodontitis. GCB & FCB was measured for all the 150 subjects. Out of 150 subjects, 10 subjects were diagnosed as diabetic patients (3 in Group 1 and 7 in Group 2). (Table 1)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Diabetic</td>
<td>3</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Non Diabetic</td>
<td>87</td>
<td>62.14</td>
<td>53</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 1: Group wise distribution of subjects according to their diabetic status.
Table 2: GCB & FCB according to periodontal status.

<table>
<thead>
<tr>
<th>Periodontal status</th>
<th>GCB</th>
<th>FCB</th>
<th>P value</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Gingivitis</td>
<td>107.92</td>
<td>21</td>
<td>107.87</td>
<td>21</td>
</tr>
<tr>
<td>Periodontitis</td>
<td>135.83</td>
<td>53.85</td>
<td>135.53</td>
<td>53.85</td>
</tr>
</tbody>
</table>

Table 3: Mean Gingival score in Diabetics & non diabetics

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean Gingival Score</th>
<th>SD</th>
<th>F value</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic</td>
<td>10</td>
<td>2</td>
<td>0.667</td>
<td>4.132</td>
<td>0.044*</td>
</tr>
<tr>
<td>Non - Diabetic</td>
<td>140</td>
<td>1.707</td>
<td>0.724</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant (p<0.05)
F indicates levene’s test of equality of variances.

Table 4: Mean Plaque score in Diabetics & non-diabetics

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean Plaque Score</th>
<th>SD</th>
<th>F value</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic</td>
<td>10</td>
<td>2.43</td>
<td>0.354</td>
<td>3.153</td>
<td>0.03*</td>
</tr>
<tr>
<td>Non – Diabetic</td>
<td>140</td>
<td>1.22</td>
<td>0.63</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant (p<0.05)
F indicates levene’s test of equality of variances.

The mean GCB in Group 1 was 107.92 mg/dl with standard deviation of 21 mg/dl. Similarly the mean FCB in Group 1 was 107.87 mg/dl with standard deviation of 21 mg/dl. A perfect positive correlation was observed between GCB and FCB measurements among subjects in Group 1. This correlation was found to be highly statistically significant with P value <0.001 (Table 2). Also on comparison of gingival crevicular blood glucose and finger-prick blood glucose measurements of Group I subjects, the Pearson's correlation coefficient showed an r – value of 1.00 and a P-level <0.001. (Table 2). On comparison of the mean Plaque score and Gingival Index scores, Mean Score in Group 1 is 1.43 ± 0.52 and in group 2 is 2.16 ± 0.76. A statistically significant difference was also noted in the Plaque score (Table 3) and Gingival score (Table 4) with a p value of Diabetic group have higher score than non-diabetic group.

**DISCUSSION**

The present study aims to estimate gingival blood glucose in a periodontal population...
for screening of diabetes mellitus. Gingival Capillary Blood and Finger Capillary Blood were measured in each patient with or without a positive history of diabetes using a second-generation self-monitoring glucometric device. When GCB glucose measurements were compared with FCB glucose measurements in diabetic patients, a very strong positive correlation was seen, which was found to be statistically significant (p value < 0.05).

Results obtained in present study, interestingly, are in consonance with studies carried out by YS Khader et al. (2008)\(^9\), which concluded that periodontal diseases as measured by Mean Gingival Index, Probing Pocket Depth, Clinical Attachment Level, Plaque Index and Mobility score was more severe in diabetics than non-diabetics. In another study done by Tandon V et al. (2015)\(^20\) stated that with the increase in fasting blood sugar levels, there was significant rise in Probing Pocket Depth, Plaque Index and Gingival Index.

The results of this study are also in agreement with the studies conducted by Parker et al. in 1993\(^14\), who examined diabetic patients with unknown periodontal status, and wherein a very strong correlation was observed between gingival crevicular, finger capillary blood and the collected intravenous blood glucose measurements. In the study by Beikler T et al. 2002\(^11\) a strong correlation was observed between GCB and FCB glucose levels when diabetic and non-diabetic patients with moderate to advanced periodontitis were examined. Kabadi UM et al. (1994)\(^21\) also deduced that the clinic glucometer is a suitable alternative to a clinical laboratory for user proficiency checks.

In the present study, the GCB measurements showed marginally higher measurement in some subjects when compared to FCB glucose measurements with minimum difference of -2 in both groups & maximum difference of 2 in gingivitis group & 1 in periodontitis group. This variation can be due to dilution by GCF when collecting the crevicular blood. This fact of a possible contamination leading to marginally higher values has been confirmed by Muller HP et al.(2004).\(^17\)

According to public health service estimation, nearly one patient per hundred (1 percent) has undiagnosed or potential diabetes.\(^13\) In the present study, patients belonged to both gingivitis & periodontitis group were screened for the random blood glucose sampling. The random blood glucose values of over 140mg/dl, were further confirmed by evaluation of Fasting Blood Glucose levels. The random blood glucose values of over 140mg/dl were considered to be positive for diagnosis of Diabetes.\(^13\) These patients were therefore referred to a physician for further management. The basic nature of periodontal disease consists of the process of gingival injury and repair, which is expressed as inflammation of the gingival tissues and its vasculature. Hence, subjects with periodontal diseases could be at a slightly higher risk of being diagnosed with diabetes\(^13\). Only 6.6% patients were diagnosed to be diabetic according to the present study. It is, thus, considered very beneficial for the patient’s medicare, having been unaware of it earlier. The outcomes of present study indicate that gingival crevicular blood collected during diagnostic periodontal examination may be an excellent source of blood for glucometric analysis. The sampling procedure performed in the study is much easier and less time consuming; since no additional tools are necessary to collect GCB and adequate amount of blood was found to cover the strip. Contrastingly, Muller HP et al. 2004\(^17\) concluded that during routine periodontal
examination, there is no advantage of using gingival crevicular blood for the testing of blood glucose as bleeding on probing was not considered to be reliable in every third case. This limitation of insufficient bleeding on probing was however, not observed in the present study.

As adequate blood flow may not be obtained from non-inflamed gingiva, this method of GCB estimation can only be carried out in patients who exhibit at least one area of inflamed periodontal tissue. Possible discrepancy may also be seen due to the dilution of blood oozing from sulcus after probing gingival crevicular fluid. However this was minimized in the present study by using approx. 3µl of blood sample. Although venous & capillary blood samples have, till date, been considered as a gold standard for screening of diabetes mellitus in a medical setup, the use of gingival crevicular blood during dental office screening offers a potentially promising alternative in periodontal patients for blood glucose estimations for undiagnosed or potential cases of diabetes, thus preventing its various complications & hence successfully bringing down the high morbidity & mortality of diabetic patients too.

CONCLUSION

Gingival crevicular blood collected during periodontal examination might be an alternative source for glucometric analysis, in patients exhibiting atleast one inflamed site with bleeding on probing for screening of Diabetes mellitus. A high degree of correlation in blood glucose estimation between Gingival Crevicular Blood & Finger Capillary Blood samples confirms the former to be another reliable source. As this technique is reliable, easy to perform, and almost atraumatic for the patient, it can be concluded that it may help to diagnose Diabetes mellitus during routine dental and periodontal checkups in unsuspecting patients & thus may prevent consequent high morbidity and mortality, if left undiagnosed.

REFERENCES

Conflict of Interest: None

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