Type II Diabetes Screening at the Periodontal Visit: Patients Experience with Two Screening Methods- A Descriptive Study

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Abstract

Aim: To evaluate the role of gingival crevicular blood as a screening and monitoring tool by comparing with intravenous blood glucose levels. To describe the patients, attitude and experience towards different tools used for screening / monitoring of diabetes mellitus also to know the patients attitude, knowledge, and perception towards the importance of diabetic control.

Materials and Methods: The present study was carried out in a total of 75 subjects age range of 30-75 years, reported to the outpatient Department of Periodontology, Rajarajeswari Dental College and Hospital, Bangalore. Blood Samples will be collected from each subjects from gingival crevicular blood (GCB)and Intravenous blood (IVB) for HbA1c and random blood sugar analysis.

Results: Statistically analyses was done using spearman's rank correlation coefficient and the result showed picture-perfect correlation of hba1c and RBS levels in both IVB and GCB samples. The results showed that 0.996 correlation in hba1c levels and 0.999 correlation in RBS levels respectively.

Conclusion: Within the limits of the present study, it can be concluded that gingival crevicular blood (GCB) collected during oral examination is an excellent source for assessing the blood glucose level. This technique is safe, easy to perform, and comfortable for the patient and therefore, act as an additional source of diagnosing diabetes and provides a more objective indicator for referring patient to physicians. Thus, it enhances the Dentist role as a member of the health team by identifying the undiagnosed asymptomatic DM. On evaluating the patients experience, we found this as a novel diabetes screening approach which is well-tolerated, convenient and acceptable to patients.

Keywords: *GCB; IVB; Diabetes Mellitus; Periodontics; HbA1c; RBS*

Introduction

Periodontitis and diabetes are common, complex, chronic diseases with an established bidirectional relationship. That is, diabetes (particularly if glycaemic control is poor) is associated with an increased prevalence and severity of periodontitis, and, severe periodontitis is associated with compromised glycaemic control. Periodontal treatment (conventional non-surgical periodontal therapy) has been

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associated with improvements in glycaemic control in diabetic patients, with reductions in HbA1c levels by approximately 0.4% following scaling and root planing. For these reasons, managing of periodontitis in people with diabetes is predominantly important. The bidirectional relationship between diabetes and periodontal disease has been well documented [1]. Diabetes has been shown to be a risk factor for periodontal disease, and it is established as a 6th complication. The dental team therefore has an important role to play in the management of people with diabetes [2].

Periodontal diseases are influenced by diabetic condition and complicates through several pathological mechanisms including production of stress, exaggerated hormones which antagonizing insulin action, elevated circulating levels of interleukin (IL)-6, tumour necrosis factor (TNF-a) which there by worsen insulin resistance and there by impair glycaemic control [3].

It is observed that many persons visit a dental provider than the primary care provider (PCP) each year, so the dental visit may act as an opportune site for diabetes screening and monitoring blood glucose [4]. Investigators have identified that there is a large group of patients with mild asymptomatic diabetes mellitus whose disease remains undetected unless blood tests are employed routinely. The blood tests usually employed involve the use of a needle prick to collect the sample which is usually painful and uncomfortable for the patient. Hence, it is necessary to search for non-invasive yet sensitive and specific alternative methods for sample collection [5-6].

Screening of diabetes at the time of periodontal examination provides an additional venue to diagnose and reduce the diabetic burden of the society [7]. Periodontal examination as a rule comprises of careful probing of periodontal pockets which result in some amount of bleeding from the gingival sulcus. Instead of swabbing and disposing the gingival crevicular blood this can be employed to assess and monitor blood glucose level [8].

Using dental office for screening diabetes mellitus with gingival crevicular blood as a biomarker or sample is a relatively new concept and only a few studies have been carried out. The advantages of utilising blood collected following periodontal probing are two-fold that is less invasive and well tolerated, than another screening methods [9,10].

However, there is only limited data access regarding gingival crevicular blood glucose level and its matching with glucose level of IVB estimated by glycated hemoglobin (HbA1c) (oxitoturbedometric method) among south Indian population. Hence this study was carried out:

- To evaluate the role of gingival crevicular blood as a screening and monitoring tool in contrast to intravenous blood glucose for computing both random blood sugar levels and glycated haemoglobin (HbA1c) in known diabetic individuals.

- To describe the patient's insolence and experience towards the different methods used for monitoring of diabetes.

- To describe the patients, insolence, knowledge, and perception towards the importance of diabetic control and its role in periodontal treatment.

Material and Methods

Source of Data

The present study was carried out in a total of 75 subjects with age range of 30 - 75 years, reported to the outpatient Department of Periodontology, Rajarajeswari Dental College and Hospital, Bangalore. The study protocol was approved by the ethical committee of The Rajarajeswari Dental College and Hospital, Bangalore.

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The study was carried out for a period of one year. The subjects were selected for the study based on the following inclusion and exclusion criteria:

Inclusion Criteria

1. Routine patients presenting to clinic who have been diagnosed with diabetes.

2. Age range between 30 - 75 years.

3. Patient should have more than 10 natural teeth.

Exclusion Criteria

1. Subjects on any medication taken within 6 months which may alter the periodontal status.

2. History of bleeding disorders.

3. Pregnancy

4. Haemolytic anemia/recent significant blood loss

5. Patients on medications that interfere with blood coagulation.

6. History of severe systemic disease that preclude regular care by dentist.

All potential participants will be explained the need and design of the study and written informed consent will be obtained from each individual prior to the commencement of the study.

Study Protocol

A proforma was designed for the present study so as to have a systematic and methodical recording of all the observations and information. The appropriate data comprising of details of the chief complaint, preliminary history etc., were recorded in the proforma. Clinical examination was carried out in a dental chair, under standard conditions of light.

Method of Collection of Data

This descriptive study was carried out on randomly selected 75 subjects. Blood Samples will be collected from each subjects from gingival crevicular blood (GCB) and Intravenous blood (IVB) for HbA1c and random blood sugar analysis. The sample size were determined based on power analysis at confidence interval of 90%.

Procedure for Collection of Sample

Maxillary sextant area was selected for collecting the gingival crevicular blood sample as this area offers best access. The area was isolated with cotton rolls to avoid saliva contamination and dried with compressed air. The probing was repeated if necessary to obtain a sufficient quality and quantity of blood for diagnostic purpose. Dispo van (insulin syringe) is used to collect 0.3 microns of blood from gingival crevices and transferred to EDTA coated test tubes. These are sent to laboratory for measuring HbA1c. Random blood sugar level of GCB is measured directly using ONE TOUCH SELECT SIMPLE GLUCOMETER®.

Intravenous blood is collected and transferred to the ETDA coated test tube. These are sent to laboratory for measuring HbA1c. Random blood sugar level of IVB is directly measured using ONE TOUCH SELECT SIMPLE GLUCOMETER®.

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HbA1c is measured using OXY-Turbidimetric method

For this first 500 µl of R3 is added to sample cup to that 10 microns of blood is added then the sample cup is incubated for 5 mints in room temperature, then it is placed in sample tray, according to position in the ERBA Mannheim XL-640®. Now in the machine automatically sample probe carries this above sample onto the curvetter, R_1 and $R_{2a \text{ and } b}$ reagents are added into the curvetter by reagent probe and now the samples are mixed by mixer probe. Processing time will be 10 minutes, in monitor the result will be displayed corresponding to the position number disclosed in monitor.

Principle

Hemoglobin A1C (HbA1c) is directly determined in whole blood using this method, using an antigen and antibody reaction. Total hemoglobin and HbA1c compite for the unspecific absorption rate to the latex particles (R_1). When anti-human HbA1c monoclonal antibody is added (R_2), latex- HbA1c-anti-human HbA1c antibody complex is formed. The presence of goat anti-mouse IgG polyclonal antibody causes the agglutination of the particles (complexes). The amount of agglutination is proportional to the concentration of the HbA1c in the sample and can be measured by turbidimetry.

RBS is measured using ONE TOUCH SELECT SIMPLE GLUCOMETER®

First the contact bar of test strip is directly inserted into test port, now for a top edge of test strip a drop of blood is applied, conformation window conforms wither quantity of blood is sufficient or not. Within few seconds the result will be displayed in mg/dl.

Principle

The random blood glucose monitoring system 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. During this reactions electrons generated or transferred from 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.

Periodontal status evaluation

Clinical parameters assessed for this study were gingival index, gingival bleeding index, and probing pocket depth.

Figure 1: Show procedure of blood collection and its analysis of HbA1c levels.

Statistical Analysis

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Chi-Square Test (also chi squared test or χ^2 test) is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-square distribution when the null hypothesis is true.

Spearman's Rank Correlation Coefficient or Spearman's Rho is a nonparametric measure of statistical significance between two variables. It assesses how well the relationship between two variables can be described using a monotonic function.

Results

The present study was designed to compare glycosylated hemoglobin and random blood glucose levels in samples collected from intra venous blood and gingival crevicular blood of known type-II diabetic mellitus patients. This study population consisted of 75 subjects

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with a mean age of 51.01 ± 10.96 years, of which 14 subjects were in the age group of 30 - 40 years, 20 subjects were in the age group of 41 - 50 years, 30 subjects were in age group of 51 - 60 years, 7 subjects were in the age group of 61 - 70 years and 4 subjects were in the age group of more than 70 years (18.7%,26.7% ,40%, 9.3%, 5.3% respectively) as shown in table 1 and graph 1.

Age in years	No. of patients	%
30 - 40	14	18.7
41 - 50	20	26.7
51 - 60	30	40.0
61 - 70	7	9.3
> 70	4	5.3
Total	75	100.0

Table 1: Age distribution of patients studied.
Mean 51.01 ± 10.96
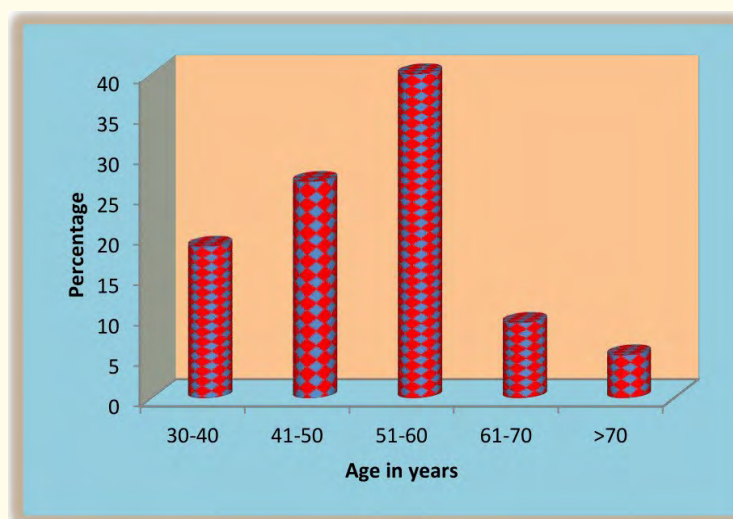
Graph 1: Age distribution of patients studied.

The comparison of the HbA1c levels in intravenous blood and gingival crevicular blood was carried out. Out of 75 subjects, 7 patients showed HbA1c levels of < 6 in both IVB and GCB, 53 patients IVB and 52 patients GCB showed HbA1c levels of 6 - 9 and 15 patients IVB and 16 patients GCB showed HbA1c level of > 9 (9.3%, 70.7%, 20%IVB 9.3%, 69.3%, 21.3% GCB respectively) as shown in table 2.

HbA1c	Intravenous blood	Gingival crevicular blood	% change
< 6	7 (9.3%)	7 (9.3%)	0.0%
6 - 9	53 (70.7%)	52 (69.3%)	-1.4%
> 9	15 (20%)	16 (21.3%)	1.3%
Total	75 (100%)	75 (100%)	-

Table 2: HbA1c distribution of patients studied.

The comparison of the random blood sugar levels in intravenous blood and gingival crevicular blood was carried out. Out of 75 patients, 4 patients IVB and 5 patients GCB showed RBS levels < 100 mg/dl, 41 patients IVB and 39 patients GCB showed RBS levels 100 - 200 mg/dl, 30 patients IVB and 31 patients GCB showed RBS levels > 200 mg/dl (5.3%, 54.7%, 40% IVB, 6.7%, 52%, 31% GCB) as shown in table 3.

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RBS	Intravenous blood	Gingival crevicular blood	% change
< 100	4 (5.3%)	5 (6.7%)	1.4%
100 - 200	41 (54.7%)	39 (52.0%)	2.7%
> 200	30 (40.0%)	31 (41.3%)	1.3%
Total	75 (100.0%)	75 (100.0%)	0.0

***Table 3:** RBS distribution of patients studied.*

Correlation of HbA1c and RBS levels were done between IVB and GCB by Karl Pearson's correlation coefficient and the results showed that 0.996 correlation in HbA1c levels and 0.999 correlation in RBS levels which shows Nearly Perfect correlation in both HbA1c and RBS levels, which is shown in table 4.

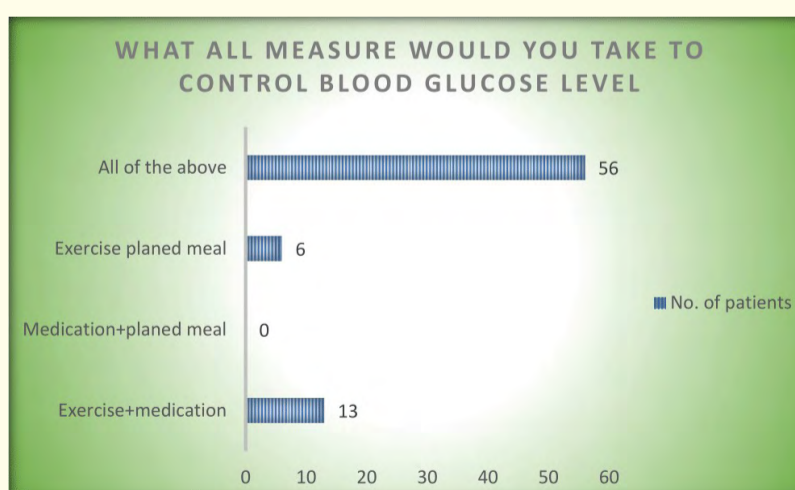|	Pearson correlation	P value
HbA1c		
Intravenous blood vs Gingival crevicular blood	0.996	< 0.001**
RBS		
Intravenous blood vs Gingival crevicular blood	0.999	< 0.001**

***Table 4:** Pearson correlation of HbA1c and RBS.*

Would you suggest GCB as a screening method to other diabetic patients (friends, colleagues) as diabetic screening method?	No. of patients	%
Yes	69	92.0
No	0	0.0
May be	18	24.0
Total	75	100.0

***Table 5:** Will you suggest GCB as a screening method to other diabetic patients.*

The analysis of the response to the questioners brought out the following:

1. **Knowledge amongst the patient regarding duration of their diabetics:** Question, 'patients were asked how long they are known diabetics', out of 75 patients, 32 patients said they are known diabetic less than a year, 10 patients said they are known diabetics since 1-2 years, 10 patients said they are known diabetic since 3 to 5 years and 13 patients said they are known diabetic for more than 5 years (42.7%, 13.3%, 13.3%, 17.3% respectively).

2. **Psychological effects of diabetics:** Question: "How frequently you are frustrated by diabetics" 7 patients said never, 49 patients said occasionally and 19 patients said frequently (9.3%, 65.3%, 25.3% respectively).

3. **Difficulties encountered regarding blood glucose screening:** Question, "what is the hardest part of blood glucose screening", 63 patients told keeping up with the schedule and technique were hardest part and 12 patients felt that cost of the test were the hardest part (84% and 16% respectively).

4. **Measures taken to control blood glucose level:** Question, "when patients were asked what are the measures taken to control blood glucose level", 13 patients said Exercise + medication, 6 patients said Exercise + planed meal and 56 patients said Exercise + medication+ planed meal (17.3%,0%,8%,74.7%respectivel).
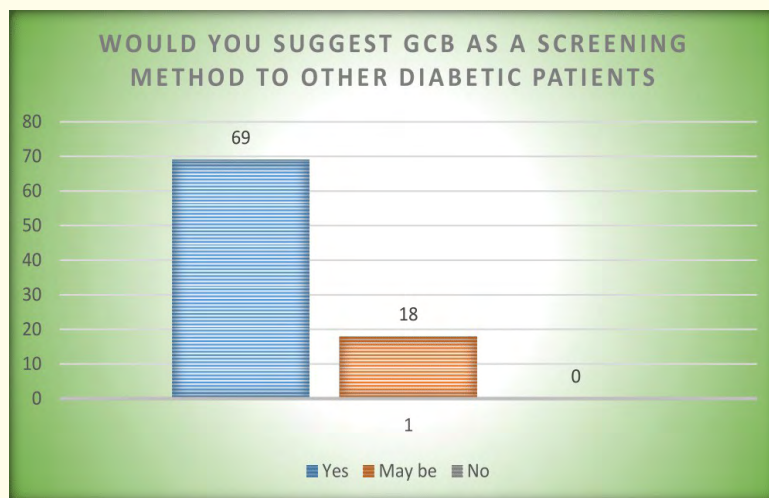

***Graph 2:** Different measures taken by patients to control blood glucose level.*

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5. **Knowledge regarding role of oral hygiene and its effect on blood glucose level:** Question, when patients were asked "role of oral hygiene and its effect on blood glucose level" 40 patients were aware of the role of oral hygiene and its effect on blood glucose level and 35 patients were not (53.3% and 46.7% respectively).
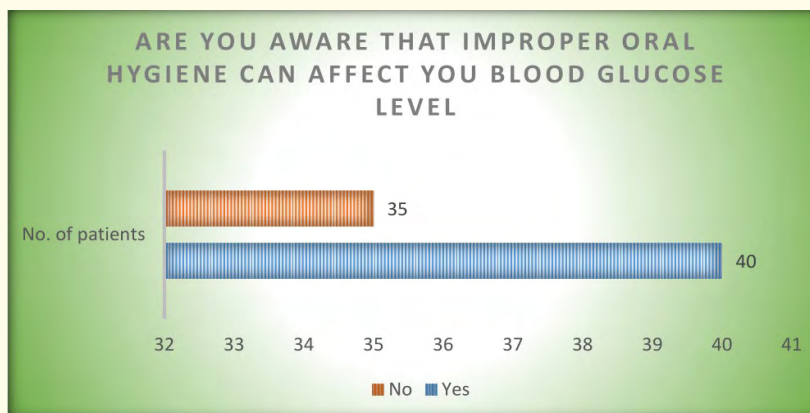
Graph 3: Shows role of oral hygiene and its effect on blood glucose level.

6. **Frequency of estimation of blood glucose:** Question, when patients were asked "How often Blood Glucose Level measured'' 7 patients said once in a week, 36 patients said once in a month, 32 patients said once in a quarter (9.3%, 48%, 42.7% respectively).

7. **Preference for methodology:** Question, "which method was preferred for diabetes screening", 23 patients said using Laboratory method with IVB, 27 said Laboratory method with GCB, 16 said Glucometer with finger stick blood and 9 said Glucometer with GCB, (30.7%, 36,21%, 3% and 1WZ% respectively) .

8. **Knowledge regarding nature of glucose estimation:** Question, when patients were asked which method of blood sample collection is non-invasive, 26 said IVB, 42 said GCB, and 7 said don't know (34.7%, 56%and 9.3% respectively).

9. **Knowledge regarding turnaround time for report:** Question, when patients were asked "which screening method is less time consuming", 7 said Laboratory method with IVB, 8 said Laboratory method with GCB, 6 said Glucometer with finger stick blood and 54 said Glucometer with GCB (9.3%, 10.7%, 8 and 72% respectively).

10. **Utility of GCB as a screening method:** Question, "Are you using GCB as diabetes screening method" 14 patients said yes and 61 subjects said no (18.7% and 81.3% respectively).

11. **Suggestion for improvement in diabetics screening:** Question, "what is the urgent improvements needed for Blood Glucose Monitoring", 18 said to make it easier, 40 said to make it cheaper, 17 said to make it more accurate (245, 53.3%, 22.7% respectively).

12. **Recommendation of GCB as an alternative for RBS:** Question, "will you suggest GCB as a screening method to other diabetic patients (friends, colleagues) as diabetic screening method", out of them 69 said yes and 18 said may be (92% and 24% respectively).

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Graph 4: *Will you suggest GCB as a screening method to other diabetic patients.*

Discussion

This study was carried out to correlate the HbA1c and random sugar levels of gingival crevicular blood (GCB) and Intravenous blood (IVB) and the in depth interview was done to know the experience of the patient of blood glucose screening at dental office.

The results of the present study revealed a higher correlation between IVB and GCB by Karl Pearson's correlation coefficient for both HbA1c and RBS. The results showed that 0.996 correlation in HbA1c levels and 0.999 correlation in RBS levels which shows nearly perfect correlation.

The results of the present study are in treaty with the study conducted by Shetty., *et al*. Strauss., *et al*. reported that GCB samples are suitable to screen for DM in individuals with sufficient BOP. Khader., *et al*. reported that GCB can be a suitable source for measuring the blood glucose level. In contrast to the above study, Muller and Behbehani failed to obtain any correlation between GCB and CFB [11].

A study done by Beikler revealed an excellent correlation between the findings of GCB glucometry and finger prick glucometry as well as with the conventional intravenous glucose estimation using the chemical autoanalyzer [12-18].

In depth interviews with patients revealed essential themes that described the experience of blood glucose screening at a dental office. These interviews was conducted based on questioner which included: how long they are known diabetics, which method they preferred for diabetes screening, their awareness on the role of oral hygiene and its effect on blood glucose level, which method of blood sample collection is non-invasive and if they would suggest GCB as a screening method to other diabetic patients.

Evaluation of the questionnaire revealed the following:

- Duration of diabetes. Out of 75 patients ,32 patients said they are known diabetic less than a year, 10 patients said they are known diabetics since 1-2 years, 10 patients said they are known diabetic since 3 to 5 years and 13 patients said they are known diabetic for more than 5 years (42.7%, 13.3%, 13.3%, 17.3% respectively).

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- Preferences of method for evaluating blood glucose,23 patients said using laboratory method with IVB, 27 said laboratory method with GCB,16 said Glucometer with finger stick blood and 9 said Glucometer with GCB (30.7%, 36.21%, 3% and 12 % respectively).

- Knowledge and awareness about the role of oral hygiene and its effect on blood glucose level. 40 patients were aware of the role of oral hygiene and its effect on blood glucose level and 35 patients were not (53.3% and 46.7% respectively). Patients and dental providers emphasized the importance of patient education about the bidirectional relationship between diabetes and periodontal disease as supporting the implementation of diabetes screening at the dental visit. Dental providers viewed this education as an opportunity to motivate the screening, while patients viewed the education they would receive from trusted oral health care professionals as an additional benefit.

- Patients were asked which method of blood sample collection is non-invasive. 26 said IVB, 42 said GCB, and 7 said don't know. (34.7%, 56% and 9.3% respectively). For periodontal patients with considerable bleeding on probing, the collection of the blood sample was generally viewed as simpler and less invasive, and eliminated concerns about sensitivity at IVB collection site.

- When patients were asked if they would suggest GCB as a screening method to other diabetic patients (friends, colleagues) as diabetic screening method, 69 said yes and 18 said may be (92% and 24% respectively). Periodontal patients believe that the dental visit is a good site for diabetes screening. Reinforcing the potential for the dental visit to serve as "a good place to check" for diabetes, patients showed good apprehension for the time-saving manner in which they were being provided with diabetes screening.

The clinical importance of present result suggest that GCB glucose can be effectively measured to detect undiagnosed diabetes as well as to check glycemic control in diabetic patients.

Conclusion

- It was found that higher correlation exists between IVB and GCB for both HbA1c and RBS levels.

- Periodontal patients believed that the dental visit is an opportune site for diabetes screening and generally preferred GCB to IVB sample collection. On examination of patients experience, we found this as a novel diabetes screening approach which is well-tolerated, convenient and acceptable to patients and also reduces time and liability and obstacles for dental providers conducting diabetes screening.

- Within the limitations of this study, it can be concluded that gingival crevicular blood (GCB) collected during examination is an excellent source for glucometric analysis. This 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, it enhances the Dentist role as a member of the health team by participating in the search for undiagnosed asymptomatic DM.

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