Original Research

Assessment of blood glucose using gingival capillary blood – A chairside method

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ABSTRACT

BACKGROUND: Diabetes Mellitus is one of the most frequent metabolic disorders which escape detection in approximately one third of the patient population. The prevalence of Diabetes Mellitus is high in patients with periodontitis. Hence, dentists play a pivotal role in the detection of undiagnosed Diabetes Mellitus in many patients.

AIM: The purpose of the present study was to evaluate whether blood from the gingiva can be used for determining glucose levels.

MATERIALS AND METHODS: In the present study, 101 patients (51 diabetic and 50 non-diabetic) with chronic periodontitis were selected and were divided into two groups i.e. Group I (Diabetic) and Group II (Non-diabetic) respectively. Blood from the gingiva of anterior teeth was collected with the stick of a glucose self-monitoring device (One Touch Ultra Soft; Lifescan, Johnson & Johnson) and the blood glucose levels were measured. At the same time, finger-stick blood was taken for glucometer analysis and also, intravenous blood was collected for measurement in a laboratory glucose analyzer.

RESULTS: The patients blood glucose values ranged from 80-197 mg / dl (Fasting) and 123-360 mg / dl (Post-prandial). The comparison between gingival capillary blood, finger-prick blood and intravenous blood showed a very strong correlation with an r-value of 0.99 (P level < 0.0001).

CONCLUSION: The data from this study has shown that gingival capillary blood collected during diagnostic periodontal examination can be an excellent source of blood for glucometric analysis.

KEYWORDS: Diabetes Mellitus, Gingival capillary blood, Chronic Periodontitis, Finger-prick blood, Intravenous blood.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder with an estimated prevalence of 7% in industrialized countries of which nearly half the cases are undiagnosed[1].India has nearly 33 million diabetic subjects today with an overall prevalence rate of 4.3 %.[2] Type 2 DM i.e. NIDDM constitutes nearly 90% of diabetic population in any country, with a prevalence of 2.4% in rural population and 11.6% in urban population.[3]

Diabetes mellitus is associated with a wide range of complications, such as retinopathy, nephropathy, micro and macrovascular disease, altered wound healing and periodontitis.[4] The early diagnosis of diabetes will help to prevent its long-term complications.

Numerous reports have suggested a close interrelationship between diabetes and periodontitis.[5] Periodontitis is now considered as the sixth complication of diabetes mellitus.[6]

The epidemiological data regarding diabetes mellitus coupled with the possible interrelationship between diabetes mellitus and periodontal disease suggests that virtually every dental surgeon and especially the periodontist is likely to encounter an increasing number of undiagnosed diabetic patients with periodontitis.

The conventional laboratory methods that are employed to screen for diabetes are time consuming and elaborative equipment are needed to employ these techniques. The advent of blood glucose monitors allows the clinician to assess blood glucose at the chair side. In contrast to laboratory method,

In contrast to laboratory method, results are obtained instantaneously, which helps the clinician to decide if further confirmatory test are required to diagnose diabetes.

Hence, the aim of this study was to determine whether Gingival capillary blood could be used to screen for diabetes mellitus by comparing :
1) gingival capillary blood glucose with finger-stick blood glucose and
2) gingival capillary blood glucose with venous blood glucose levels measured in laboratory.

MATERIALS AND METHODS

The study was carried out in the Department of Periodontology, SRM Dental College and SRM General Hospital, Ramapuram, Chennai. A total of 101 patients, whose ages ranged from 20 – 70 years were recruited in the study. Patients were selected based on the following criteria:1)Patients who are known diabetics (Type 1 and 2) and age matched non-diabetics. 2) Patients who have been diagnosed with chronic periodontitis. Patients with the following conditions and medications were excluded from the study. i) Bleeding disorders and other sysytemic diseases ii)Anti-coagulant, NSAID, Ascorbic acid iii) Pregnancy.

An informed consent was taken from the patients before starting the study. 51 diabetic patients were assigned to Group I and 50 Non-diabetic patients were assigned to Group II.

For each patient of both the groups probing pocket depth and clinical attachment level were measured by using PCP-UNC-15 probe. Periodontal probing of upper anterior teeth was done after sample collection, as it was reported that crevicular fluid may dilute the glucose concentration of the sample.

GLUCOSE MEASUREMENT
Gingival Capillary Blood Sampling (GCB)

Gingiva in relation to maxillary anterior teeth was chosen for glucose measurement as it offers ideal access and ease of sample collection. For each measurement only one test site was selected. The site with more obvious visible changes of inflammation was selected as the test site. Isolation of suitable site was done with cotton rolls. Contamination with saliva was prevented by using gauze squares and air-drying. A topical anesthetic was used before sample collection, to overcome pain, if any, which may interfere with adequate sample collection. 10% Lignocaine spray was used to anaesthetize the test site. Gauze squares were used to wipe off the excess spray on the test site (Gingiva). A sterile, single use surgical lancet (MEDIpoint, Mineola, USA) was used to elicit bleeding. A small prick was made in the interdental papilla to elicit free flow of blood in to the interdental space. The reagent test strip was inserted into the test port of "ONE TOUCH ULTRA" glucometer with contact bars end first and facing up. The test strip was pushed in until a resistance was felt. The meter then turned on automatically and the display check appeared briefly. This was followed by the symbol of blinking drop on the monitor suggesting that the meter was ready for the test. The top edge of the reagent strip of Glucometer was then placed against the bleeding site.

The blood was automatically drawn into reaction cell of the strip by capillary action. The top edge of the test strip was held against blood drop until the confirmation window was full before the meter begins to count down. Every attempt was made to obtain the blood sample on the reagent strip by a clean catch without contacting gingiva/teeth.

Finger Stick Capillary Blood Sampling

The finger stick capillary blood (FP) was collected from the lateral surface of the fourth finger of the left hand due to thinner epithelium and also since it is a finger of lesser use. The soft surface of the fingertip was wiped with surgical spirit (70% Iso propyl alcohol) and the alcohol was allowed to evaporate. The finger was punctured with a sterile lancet and the first drop of blood was wiped away and the second drop was used. According to The Albert Einstein College of Medicine (2001) Diabetes Research and Training Centre, this may reduce the risk of an inaccurate result should the sample contain excess tissue fluid (or alcohol, if it is used to clean the finger). The hand was held down and the finger tip was gently massaged (but not squeezed) to obtain a round drop of blood. The test was then performed with glucometer and results were obtained after 5 seconds.

The patient was then subjected for blood glucose estimation at Hospital (located in the adjacent building) using a sample of venous blood (IVB) from Ante-cubital vein. The venous blood (3 ml) was collected in a vacuum tube (Vaccutainer) containing 3mg of Sodium fluoride and 6 mg of EDTA. The blood sample was centrifuged to obtain plasma. The resultant plasma was analyzed for glucose using Computerized Automated Laboratory Glucose Analyzer (HITACHI-911, JAPAN). The gingival, finger-puncture and venous blood sampling took about 30 minutes to complete and they were considered to be near simultaneous measurements. The blood glucose levels of gingival capillary blood, finger stick blood and the venous blood of all the patients were documented.

RESULTS

Descriptive data are presented as mean ± SD and range values. The difference between the measurements (Gingival capillary blood, finger-prick and intravenous blood glucose values) in the same individual was tested by paired 't' test. Pearson's correlation coefficient was used to assess the relationship between different measurements.

GROUP I: (Diabetic patients with chronic periodontitis)
The mean fasting glucose level at GCB was 124.9±26.5 mg/dl, at FP was 118.5±24.5 mg/dl and at IV B was 112.5±25.4 mg/dl. A statistically significant correlation (p level < 0.001) was found between GCB and FP (r value = 0.98); GCB and IV B (r value = 0.98) and FP with IV B (r value = 0.99). (Table 1)

TABLE 1: RELATIONSHIP BETWEEN VARIOUS MEASUREMENTS (Fasting)

GROUP	C0RRELATION BETWEEN	PEARSON'S CORRELATION COEFFICIENT	
		r- value *	P - value
I	GCB and FP	0.98	<0.0001
	GCB and IV B	0.98	<0.0001
	FP and IV B	0.99	<0.0001
II	GCB and FP	0.94	<0.0001
	GCB and IV B	0.94	<0.0001
	FP and IV B	0.97	<0.0001

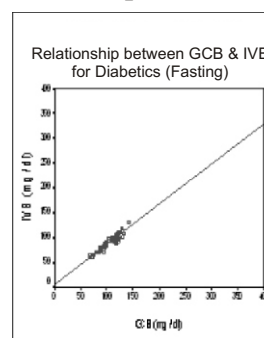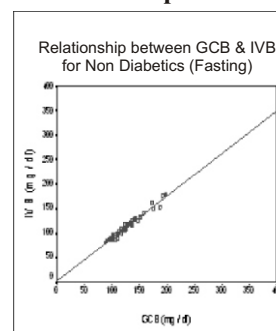## TABLE 2: RELATIONSHIP BETWEEN VARIOUS MEASUREMENTS (Post Prandial)

GROUP	C0RRELATION BETWEEN	PEARSON'S CORRELATION COEFFICIENT	
		r - value *	P – value
I	GCB and FP	0.997	<0.0001
	GCB and IV B	0.99	<0.0001
	FP and IV B	0.996	<0.0001
II	GCB and FP	0.96	<0.0001
	GCB and IV B	0.91	<0.0001
	FP and IV B	0.94	<0.0 001

The mean post postprandial glucose level at GCB was 179.6 ± 51.9 mg/dl, at FP was 173.0 ± 50.6 mg/dl and at IV B was 166.8 ± 48 mg/dl. A statistically significant correlation (p level < 0.001) was found between GCB and FP (r value = 0.997); GCB and IV B (r value = 0.99) (Graph 1) and FP with IV B(r value = 0.996). (Table 2)

GROUP II : (Non-diabetic patients with chronic periodontitis):

The mean fasting glucose level at GCB was 103.9 ± 7.9 mg/dl, at FP were 97. 4 ± 17.5 mg/dl and at IV B was 89.6 ± 15.4 mg/dl. A statistically significant correlation (p level < 0.001) was found between GCB and FP (r value = 0.94); GCB and IV B (r value = 0.94) (Graph 2) and FP with IV B(r value = 0.97).

Graph: 1

Relationship between GCB & IVB for Diabetics (Fasting)

Graph: 2

Relationship between GCB & IVB for Non Diabetics (Fasting)

The mean postprandial glucose level at GCB was 141.4 ± 14.0 mg/dl, at FP was 135.0 ± 13.6 mg/dl and at IV B was 127.6 ± 13.8 mg/dl. A statistically significant correlation (p level < 0.001) was found between GCB and FP (r value = 0.96); GCB and IV B (r value = 0.91) and FP with IV B (r value = 0.94).

DISCUSSION

Undiagnosed diabetic patients are at significantly increased risk for development of complications and the bidirectional relationship of diabetes with periodontitis underscores the necessity for early detection of diabetes for successful management of periodontitis in these patients. It has been estimated that about one third of type 2 diabetes mellitus cases are undiagnosed.[7] In addition, recent data indicates that the incidence of type 2 DM may be increasing by up to 6% per year.[8] Since periodontal inflammation with or without complication factor of DM is known to produce ample extravasation of blood during diagnostic periodontal examination,[9] no extra procedure, e.g. finger puncture with a sharp lancet is necessary to obtain blood for glucometric analysis.

The blood glucose monitor / Glucometer is a portable electronic gadget which works on the same principle as laboratory glucose analyzer (Glucose oxidase method), but requires very little blood sample (1-3µl) and can provide fairly accurate results within seconds Stein GM et al (1969) conducted a study to screen for diabetes using gingival blood by a chair side method.[10] They reported that dental surgeons seemingly would be more secure in obtaining blood samples from the gingival tissues than in using conventional blood collection methods. They transferred

blood onto the test strip by wiping blood directly from hemorrhagic gingival tissue with the test strip itself. Use of a glucose self-monitor, which is self-timing and requires no wiping, was described.[11] The direct use of test strip of glucometer to collect blood sample from gingiva was proposed.[1]

Though better correlations between gingival and finger stick samples were reported in these studies when compared to previous studies, the study had limitations that the contamination of the blood sample from crevicular fluid was possible and inevitable. Thus, gingival crevicular blood after probing may not represent true capillary blood glucose measurement.

To overcome the problem of contamination with crevicular fluid, in our study lancing of the gingiva on the outer surface was done after anesthetizing the sample site and thus eliminating any possibility of contamination with crevicular fluid.

In the present study, 50 patients were divided into two groups i.e. Group I: Diabetic patients with chronic periodontitis, Group II: Non-diabetic patients with chronic periodontitis, GCB and FP blood glucose were measured in each patient using self-monitoring glucometric device. Since the corrected laboratory measurement is considered to be the true (or reference) value, its comparison to GCB and FP blood measurements allows the evaluation of accuracy and precision of each blood collecting technique and the self-monitor.

GROUP I: (Diabetic patients with chronic periodontitis)

The mean fasting glucose level at GCB was 124.9±26.5 mg/dl, at FP was 118.5±24.5 mg/dl and at IV B was 112.5±25.4 mg/dl. On comparison between GCB glucose measurements, FP blood glucose measurements and corrected IV B glucose measurements, a very strong correlation was seen with an r value of 0.99, which was statistically highly significant (p level < 0.001).

The mean postprandial glucose level at GCB was 179.6±51.9 mg/dl, at FP was 173.0±50.6 mg/dl and at IV B was 166.8±48.1 mg/dl. On comparison between GCB glucose measurements, FP blood glucose measurements and corrected IV B glucose measurements, a very strong correlation was seen with an r value of 0.99, which was statistically highly significant (p level < 0.001). The results of this study are in agreement with the study conducted by Parker RC et al (1993),[11] where diabetic patients with unknown periodontal status were examined, and wherein a very strong correlation was observed between gingival capillary, finger prick capillary and intravenous blood glucose measurements.

GROUP II: (Non-diabetic patients with chronic periodontitis)

The mean fasting glucose level at GCB was 103.9±7.9 mg/dl, at FP was 97.4±17.5 mg/dl and at IV B was 89.6±15.4 mg/dl. On comparison of GCB glucose and FP blood

glucose measurements, a very strong correlation was seen with an r value of 0.98, which was statistically highly significant (P level < 0.001). The results are in agreement with the study conducted by Beikler T et al[1], Strauss SM et al (2009)[13] and Ardakani MR et al (2009)[14] wherein, a strong correlation was observed between GCB and finger stick capillary measured blood glucose when diabetic and nondiabetic patients with moderate to advanced periodontitis were examined.

The mean fasting glucose level at GCB was 141.4±14.0 mg/dl, at FP was 135.0±13.6 mg/dl and at IV B was 127.6±13.8 mg/dl. On comparison of FP blood and corrected IV B glucose measurements, a very strong correlation was seen with an r value of 0.98, which was statistically highly significant (p level < 0.001). On comparison of GCB glucose and corrected IV B glucose measurements, a very strong correlation was seen with an r value of 0.99, which was statistically highly significant (P level < 0.001).

The comparative results of FP blood and IV blood, and, GCB and IV blood glucose measurements showed a strong correlation in the present study. However, as no references are available till date in relation to non-diabetic patients comparing FP blood and GCB with IV blood glucose measurements, the results could not be compared with any previous studies. In the present study, in the Group II (Non-diabetic with chronic periodontitis) patients, with the random blood glucose sampling, out of 25 patients, 3 patients showed potential diabetes (12%), with blood glucose values of over 140mg/dl, out of which 2 were males and 1 female, with age ranging from 35-40 years. The blood glucose values of over 140mg/dl were considered to be positive.[14] These patients were referred to a physician for confirmation and treatment.

Periodontitis and diabetes are both generally diseases of advancing age. Hence, periodontal population therefore is considered at a slightly higher risk than non-periodontal population, as seen in this study, 12 % of new diabetic patients were discovered.[13]

The strong correlation obtained in the present study on comparison between the various blood glucose measurements indicates the feasibility of using Gingival capillary blood as an alternative to the FP blood and IV B. However, in a study conducted by Muller HP et al (2004),[7] on diabetic and non-diabetic patients with gingivitis and moderate to advanced periodontitis, the results failed to provide any evidence for the usefulness of Gingival crevicular blood for testing blood sugar during routine periodontal examination. But the difference in our study is that blood is obtained before probing the gingival sulcus by lancing the outer surface of the gingiva. Hence, the possibility of contamination by sulcular fluid is eliminated and a close to accurate blood glucose estimation could be expected.

SUMMARY AND CONCLUSION

Within the limitations of this study, the following conclusion can be made that GCB collected during diagnostic periodontal examination may be an excellent source of blood for glucometric analysis.

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