

## Correlation between Levels of Sulcular and Capillary Blood Glucose

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### Abstract

**Aim:** The aim of this study was to evaluate the correlation between capillary blood glucose levels (CBGLs) and sulcular blood glucose levels (SBGLs) using blood obtained from gingival tissue during routine periodontal examinations to determine if sulcular blood samples can be used as a non-invasive means to diagnosis blood glucose levels.

**Methods and Materials:** Thirty non-diabetics and 30 diabetic patients with moderate to severe periodontitis were included in the study and subjected to routine clinical periodontal examinations. Blood was collected using a 1.6-1.8 mm diameter micro bite collection tube to transport the sample from the gingival sulci of anterior teeth following periodontal pocket probing to a test strip of a glucose self-monitoring device. As a control, capillary blood was taken with a finger-stick. Statistical analysis was performed using the Pearson's correlation coefficient and a t-test.

**Results:** The blood glucose levels in patients ranged from 58 mg/dl to 477 mg/dl, and the values of blood samples taken from gingival sulcus or finger tip of the same patient showed a very high intra-patient correlation ( $r = 0.99$ ,  $p < 0.0001$ ).

**Conclusion:** The results of this study suggest sulcular blood from a routine periodontal examination may be used for diabetes mellitus screening.

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**Clinical Significance:** Considering 50% of diabetics remain undiagnosed, testing sulcular blood may provide a suitable method for identifying potential diabetic patients during routine dental visits since there is a correlation with capillary blood. Appropriate referrals to a physician can then be made when warranted.

**Keywords:** Diabetes mellitus, sulcular blood glucose level, SBGL, capillary blood glucose level, CBGL, periodontal disease, bleeding on probing

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## Introduction

Diabetes mellitus is one of the most common metabolic conditions resulting in metabolic disruption of lipids, proteins, and carbohydrates. Increased levels of blood glucose have a detrimental effect on the eyes, nerves, kidneys, blood vessel, and other organs.<sup>1,2</sup> Considering the profound impact of this disease almost 50% of afflicted patients are unaware of their problem.<sup>1,2</sup>

Diabetes might also be accompanied with oral symptoms such as:<sup>1-4</sup>

- Xerostomia
- Bacterial, viral, and fungal infections
- Delayed healing
- Increased caries rates and more severe lesions
- Periodontal disease
- Abscess formation (periodontal/periapical)
- Burning mouth syndrome

Periodontal disease is the sixth most common complication of diabetes making it a major risk factor influencing the incidence and severity of periodontal related problems.<sup>3,4</sup> The prevalence of diabetes mellitus in patients with periodontitis is greater than in periodontally healthy patients. Therefore, a high number of patients with periodontitis may have undiagnosed diabetes mellitus.

An increased severity of attachment loss and bone resorption is usually seen among diabetic patients compared to control subjects.<sup>5-7</sup> The degree of attachment loss and bone resorption among patients with uncontrolled diabetes appears to be greater in comparison with those who are controlled diabetics which helps to confirm the negative effect diabetes can have on periodontal health.<sup>7-9</sup>



Diabetes is rather difficult to control in patients who also suffer from aggressive periodontitis raising the possibility that treating their periodontal disease could possibly exert a positive influence in controlling their diabetes.<sup>10,11</sup>

Blood glucose level can be measured through capillary or venous blood supply. Other studies compared the lacrimal glucose level among diabetic and non-diabetic patients with the results indicating higher lacrimal glucose levels in diabetic patients.<sup>12-14</sup> Parker et al.<sup>15</sup> and Beikler et al.<sup>16</sup> reported a correlation between sulcular blood glucose levels (SBGLs) and capillary blood glucose levels (CBGLs) by evaluating two indices among diabetic patients. Various methods are now being used to evaluate the level of blood glucose. The glucometer is one of the most popular and non-invasive means for this purpose.

The aim of this study was to evaluate the correlation between the CBGL and the SBGL to determine if sulcular blood samples can be used as a non-invasive means to diagnosis blood glucose levels. Considering 50% of diabetics

remain undiagnosed, testing sulcular blood may provide a suitable method for identifying diabetic patients during routine dental visits if there is a correlation with capillary blood.

### Methods and Materials

Sixty patients (30 diabetic and 30 non-diabetic patients) with moderate or severe periodontitis were included in this study. There were no exclusions based on age or gender. SBGLs and CBGLs were measured using a glucometer.

Exclusion criteria included:

- Hematological discrepancies using anticoagulant drugs
- Severe cardiovascular disorders
- Hepatitis
- Renal failure

All patients provided written informed consent. After periodontal probing of the maxillary anterior sextant (due to better access and isolation), patients with pocket depths between 5-7 mm or more were included. Prior to probing, all subjects rinsed with chlorhexidine 0.12% in order to minimize microbial load in the region. Probing was carried out by a UNC 15 probe after complete isolation. Blood oozing from the gingival tissues was collected by a 1.6-1.8 mm diameter micro bite and transported to the specific “strip test” measuring area. The blood glucose level was then measured using the Prestige IQ™ Blood Glucose Monitor (Home Diagnostics, Inc., Ft. Lauderdale, FL, USA).

Blood samples of diabetic subjects were collected at the Treatment and Research Center for

Diabetes, the dental school, and a private clinic in Yazd, Iran. Non-diabetic blood samples were collected at the Yazd School of Dentistry and at a private dental office. Before collecting a capillary blood sample patients were asked to wash the tip of their right index finger with soap and water. Sampling was carried out using an auto-lancet device to puncture the skin, and the blood drop was then transported to the glucometer device for analysis.

The data was recorded and analyzed with the “Pearson correlation” and paired t-tests using the SPSS version 11.5 statistical software program (SPSS, Inc., Chicago, IL, USA).

### Results

Sixty patients (30 males and 30 females) took part in this study with the mean age of 42.98 years. The mean capillary blood glucose (MCBG) level and the mean sulcular blood glucose (MSBG) levels derived from all samples was 190.57 and 168.6, respectively. The MCBG level was 269.73 for the case group and 111.4 for the controls. The MSBG level among the case group was 240.27 and the control group was 97.03.

Twenty-one (70%) diabetic patients and five (17%) non-diabetics had a positive familial history of diabetes. Tables 1 and 2 show a significant difference in the MCBG and MSBG levels between the case and control groups, respectively (p=0.0001).

A familial history of exposure among the two groups seems to be significantly different.

Table 1. Mean CBGLs.

Group	Number	Mean	Minimum	Maximum	SD	Test
Case	30	269.73	139	477	84.91	T=9.39
Control	30	111.40	64	242	36.35	P=0.0001

Table 2. Mean SBGLs.

Group	Number	Mean	Minimum	Maximum	SD	Test
Case	30	240.27	129	418	74.95	T= 9.49
Control	30	97.03	58	242	31.67	P=0.0001

MCBG and MSBG levels among gender types (Tables 3 and 4) and different degrees of severity of periodontitis (Tables 5 and 6) were not statistically significant. However, a greater mean blood glucose level was observed in patients with severe periodontal disease. Nevertheless, regardless of subgroup classifications, there was a high correlation between the MSBG and MCBG levels among all participants ( $r=0.997$ ,  $P=0.0001$ ).

Moreover, a high correlation was also observed between the MSBG and MCBG level in patients with various degrees of periodontal severity (Figure 1 and Table 7).

### Discussion

Diabetes mellitus is a condition that can lead to a wide range of complications such as retinopathy,

nephropathy, neuropathy, vascular disorders (micro and macro angiopathies), delayed healing procedures, and periodontal diseases.<sup>1,2</sup>

The American Diabetic Association recommends all healthy individuals 45 years of age or older without risk factors of exposure to diabetes should be evaluated for diabetes every three years. Those who have risk factors for diabetes should be evaluated at an earlier age and at more frequent intervals.

There has been a recent effort to develop an accurate, safe, non-invasive means of evaluating the blood glucose level.<sup>17</sup> Sulcular bleeding is a normal consequence of periodontal examinations due to inflammation of the tissues regardless of whether the patient is diabetic or not.<sup>18</sup> Thus,

**Table 3. Mean CBGLs by gender.**

Group	Number	Mean	Minimum	Maximum	SD	Test
Males	30	183.53	64	384	103.21	T= 0 .53
Females	30	197.60	91	477	103.65	P= 0.60

**Table 4. Mean of SBGL by gender.**

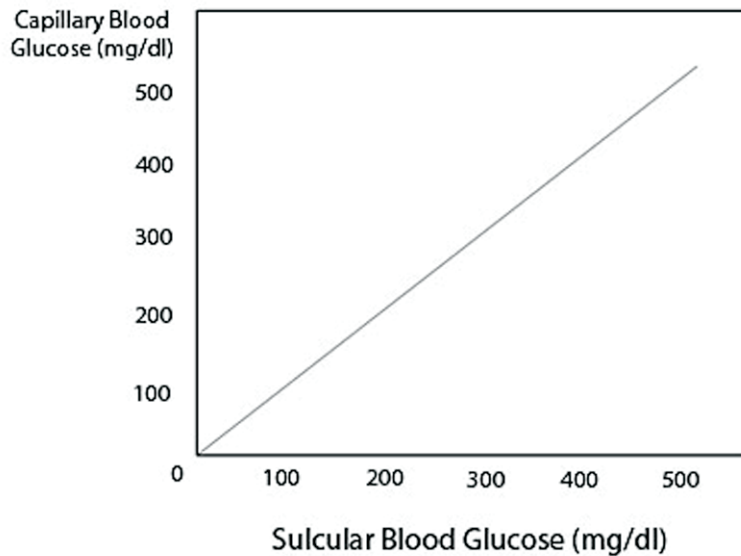
Group	Number	Mean	Minimum	Maximum	SD	Test
Males	30	163.23	58	359	93.28	T=0.45
Females	30	174.07	91	418	92.04	P=0.65

**Table 5. Mean CBGLs by severity of periodontal disease.**

Group	Number	Mean	SD	Test
Moderate Periodontitis	24	161.75	92.37	T= 1.81
Severe Periodontitis	36	209.78	106.09	P= 0.076

**Table 6. Mean SBGLs by severity of periodontal disease.**

Group	Number	Mean	SD	Test
Moderate Periodontitis	24	142.54	80.93	T= 1.83
Severe Periodontitis	36	186.06	95.90	P = 0.072



**Figure 1.** Correlation between MCBG and MSBG.

**Table 7. Correlation between capillary and SBGLs.**

Group	Number	CBGL	SBGL	Test
Case	30	1	0.993	Odds = 0.01
Control	30	1	0.990	Odds = 0.01

a dental clinician could use this sulcular blood to test for glucose levels instead of perforating the patient's finger tip to obtain a blood sample and make a referral to a physician for further evaluation for diabetes when warranted. The primary objective of this study was to evaluate the SBGL in order to reach a safe, noninvasive, and fast method to assess the diabetic status via periodontal examinations.



Parker et al.<sup>15</sup> reported a high degree of correlation between sulcular and capillary blood glucose ( $r=0.8$ ) which was consistent with the present study ( $r=0.99$ ).

Beiker et al.<sup>16</sup> also reported a high degree of correlation in a study using a glucometer device to compare capillary and SBGLs ( $r=0.98$ ) which was also consistent with the findings of the present study.



In the year 2001, Almas<sup>19</sup> stated the severity of periodontal disease is directly associated with the blood glucose level. The subjects of his study were diabetic type II patients. This was also confirmed in the present study where 20 patients with severe periodontitis also exhibited higher blood glucose levels.

Patino-Martin et al.<sup>20</sup> studied the prevalence rate of periodontitis among uncontrolled diabetic patients and healthy or controlled diabetic patients. The results indicated periodontitis is more prevalent in patients with uncontrolled diabetes compared to healthy subjects. The same results were attained in the present study.

Lu et al.<sup>21</sup> evaluated the effect of variables on the severity of periodontal disease among diabetic patients in 2004. They concluded diabetes itself is the primary factor exerting an influence on the severity of periodontitis with age being another influencing factor as elderly patients face more severe periodontal diseases. These findings were also consistent with the present study.

## Conclusion

Within the limits of this study, it can be concluded there is a high correlation between SBGLs and CBGLs among diabetic and healthy subjects, regardless of gender. A familial history of diabetes and greater severity of periodontal disease coincided with the patients suffering from diabetes.

## Clinical Significance

Considering 50% of diabetics remain undiagnosed, testing sulcular blood may provide a suitable method for identifying potential diabetic patients during routine dental visits since there is a correlation with capillary blood. Appropriate referrals to a physician can then be made when warranted.

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