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Research Article

CORRELATION OF SALIVARY GLUCOSE AND BLOOD GLUCOSE AMONG DIABETICS VERSUS NON-DIABETICSMaha AlQusayer¹ and Mei AlQusayer¹.¹Princess Norah University, College of Medicine.**Abstract:**

Diabetes Mellitus is emerging as a major health problem over these years. It's a chronic condition, results in significant medical comorbidities, which directly and indirectly account for a huge component of the health care system costs. Diabetes must be managed and screened properly to maintain normal glucose level. The most commonly used laboratory diagnostic procedures is checking the blood glucose. Saliva is the second option that reflects the blood glucose status since the saliva can be collected easily (non-invasively) by individuals without training. This research is aiming to correlate salivary glucose level and blood glucose among diabetics versus non-diabetics and to evaluate the effect of oral hygiene on the salivary glucose level. We used a Study design and study sample, a Case control study design adopted to study the difference between salivary and blood glucose levels among diabetics and non-diabetics to see the difference between the results.

Objectives: *To Correlate Salivary Glucose level and blood glucose among diabetics versus non-diabetics, and to evaluate the effect of oral hygiene on the salivary glucose level.*

Methods: *This case-control study was conducted on 50 diabetic patients as the case and 50 healthy subjects as the control group. Blood and salivary glucose levels will be measured in the two groups. Questionnaire: it includes, data about demographic profile, diabetes history as duration of disease, type and possible complications, oral hygiene and Patients opinion about the glucose check machines. Salivary samples to test glucose level, a sample of about 10 ml of saliva collected all Participants were fasting. Blood glucose will be measured at the same time.*

Conclusion: *Salivary glucose is promising method that body fluids reflect the blood state and it helps in screening a diseases, but there are some challenges regarding the salivary state such as oral hygiene, diseases relates to the salivary secretion and gender. Our final study results showed a positive correlation between the blood and salivary glucose which is significantly supporting our hypothesis that was conducted among control and diabetic participants.*

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INTRODUCTION:

Diabetes mellitus as a clinical disorder has been recognized for hundreds of years. As a chronic condition, diabetes results in significant medical comorbidities, which directly and indirectly account for a huge component of the health care system costs. The basic defect in diabetes involves tissue resistance to insulin and results in abnormal glucose metabolism. In a normal person, homeostatic mechanisms maintain fasting blood glucose levels between 3.9 – 6.1 mmol/L [70-110 mg%]. There are two types of diabetes type I and type II diabetes. [1,2]

According to the International diabetes federation (IDF) and Middle East and North Africa (MENA), about 382 million people have diabetes in the world and more than 34.6 million people in the MENA Region; by 2035 this will rise to 670.9 million. There were 3.6 million cases of diabetes in Saudi Arabia in 2013. [1, 2]

Owing to the chronic nature of diabetes, many complications related to heart, kidneys and nerves can cause serious life threatening conditions for patients; therefore diabetes must be managed and screened properly to maintain normal glucose level. The most commonly used laboratory diagnostic procedures is checking the blood glucose level which many patients are used to do it by themselves at home. It is very fast and it has a high specificity but, it's uncomfortable for some of the diabetic patients specially children and it's hard for them to prick their finger multiple times as needed to measure their glucose level. [1-3]

Saliva is the second option that reflects the blood glucose status since the saliva can be collected easily (non-invasively) by individuals without training. Salivary glucose can be affected by many oral signs commonly seen in diabetes mellitus such as mouth ulcers due to poor healing process and fungal infections [3]. New devices for measuring salivary glucose are commercially available now and many studies showed that turning into saliva measuring is preferred by some patients because it is less invasive and more comfortable [4].

In the current study, the main objective is to confirm the correlation between the salivary glucose and

blood glucose and to compare between diabetics and non-diabetics regarding their salivary glucose.

Methods:

Study design and study sample , a cross-sectional study design adopted to study the difference between salivary and blood glucose levels among diabetics and non-diabetics. It was conducted in Prince Mohammed Bin Abdulaziz Hospital and Princess Nora Bint Abdul Rahman University (PNU) Riyadh , Saudi Arabia between/-it was approved by the Research and Ethical Committee at PNU. The objective of the study is to collect fifty diabetic patients and fifty health individual to participate in the study. Both Type I and type II diabetics were included. Patients who are suffering from other oral conditions or tumors/diseases of salivary glands has been excluded from the study. The total sample size is of hundred participant previous literature showed that the average salivary glucose for non-diabetics is 5 mmol/l and the minimum difference between diabetics and non-diabetics is 0.5, and the expected standard deviation is 1.

Data Collection:

A 22 questions from a close ended questioner was distributed to the control and case. The Questionnaire: it includes the following domains: a. Data about demographic profile as age and sex. b. Data about diabetes history as duration of disease, type and possible complications as diabetic foot and retinopathy c. Data related to oral hygiene as how often participants brush their teeth and history of frequent dental caries and moth ulcers. d. Patients opinion about the glucose check machines they are already using it if applicable and how they would accept measuring their glucose level though saliva instead of blood.

Data analysis:

All collected study variables will be coded numerically. All row data will be managed, processed and compiled in SPSS. Descriptive statistics as minimum and maximum value will be run in all study variables. Descriptive statistics will be used to summarize the study variables. Percentages and frequencies will be used for categorical data. Person's correlation coefficient will be used to correlate salivary and blood glucose.

RESULTS:

Table 1. Demonstrate the characteristics of the studied sample between diabetics and non-diabetics; a total of 100 participants, 50% control and the other 50% were diabetics. According to their gender 57% of them were male and 43% were female. Regarding oral hygiene (n=58, 58%) are brushing their teeth daily, while (n=25, 25%) when needed. 15% of the participants have had an oral ulcer one month ago.

Salivary diseases had the least percentage of 1%. Moreover, approximately 18% were smokers. A significant response to our main purpose in changing the method of testing the glucose level from blood to saliva, (82%) of the participants agreed, whereas 12% haven't shown interest.

Table 1.

General characteristics of the studied sample	n	(%)
Gender		
Female	57	(57.0)
Male	43	(43.0)
Diabetes type		
Type 1	10	(10.0)
Type 2	40	(40.0)
Non-diabetic	50	(50.0)
Tooth brushing		
Daily	58	(58.0)
Once or more in a Week.	17	(17.0)
When needed	25	(25.0)
Oral ulcers		
Yes	15	(15.0)
I don't remember	6	(6.0)
Denture		
Yes	10	(10.0)
Salivary diseases		
Yes	1	(1.0)
I don't remember	12	(12.0)
Smoking		
Yes	18	(18.0)
Change from blood to saliva glucose.		
Yes	82	(82.0)
No	6	(6.0)
I don't care	12	(12.0)

Table 2. Shows the criteria of the diabetic patients; 50 participated in the study. According to the treatment 50% of them are using insulin, 36% are using hypoglycemic drugs whereas 14% are using combined therapy. The frequency of measuring the blood glucose showed that 48.0% of the participant are measuring daily, while 40.0% when needed. The major difficulties that diabetic patients faced are pain which was 54.0% and the need of others help 48.0%, despite the fact price has the lowest impact among difficulties. Making the device easier was the first

priority (90.0%). Making it more precise and less painful were (74.0% and 68.0% respectively). The majority of diabetic patients trusted their devices. Among surveyed participants' complications, 22.0% had eye complication and 30.0% of them had diabetic foot.

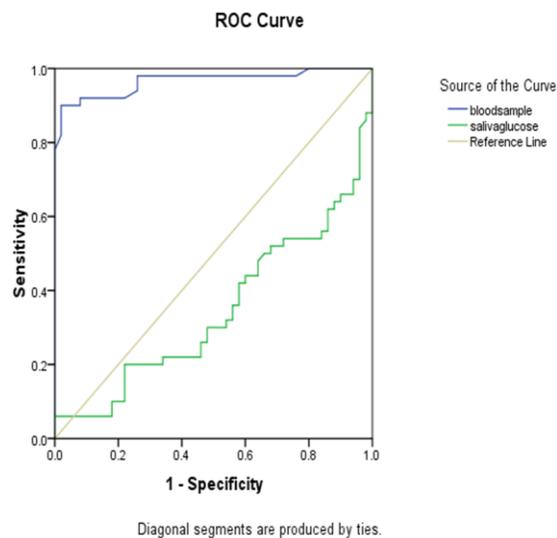
Table 2.

Criteria of the diabetic group	n	(%)
Medication		
Insulin	25	(50.0)
Hypoglycemic	18	(36.0)
Both	7	(14.0)
Do you measure your blood glucose by yourself?		
Yes	30	(60.0)
Check often		
Daily	24	(48.0)
Weekly	6	(12.0)
When needed	20	(40.0)
Difficulties in measuring blood glucose		
- Pain	27	(54.0)
- Price	9	(18.0)
- Seeing blood	12	(24.0)
- Need help from others	24	(48.0)
Things are needed to be improved in blood glucose device		
- Making it easier to use	45	(90.0)
- Making it cheaper	19	(38.0)
- Making it less painful	34	(68.0)
- Making more precise	37	(74.0)
Trust blood glucose device		
Yes	46	(92.0)
Had teeth extraction		
Yes	6	(12.0)
I don't remember	5	(10.0)
Eye surgery		
Yes	11	(22.0)
Foot ulcer		
Yes	15	(30.0)
I don't remember	11	(22.0)

	Diabetics	control	p-value
Age	50.1 ±18.7	24.6 ±10.9	<0.01
Gender			
female	19(38%)	38(76%)	<0.01
male	31(62%)	12(24%)	
Smoking	13 (26%)	5(10%)	<0.03
How often you brush your teeth			
Daily	18(36%)	40(80%)	<0.01
Weekly	10(20%)	7(14%)	
Not regularly	22(44%)	3(6%)	
History of mouth ulcer over the last month	11(22%)	4(8%)	<0.01
History of salivary gland diseases	0(0%)	1(2%)	<0.06
Blood glucose	199.58 ±76.286§	83.58 ±18.948	.000
Salivary glucose	5.7708 ±9.30783	6.9974 ±6.40135	.007

Table 3. Correlation of salivary glucose and blood glucose among diabetics. The correlation coefficient is 0.3 and the p-value is 0.03, which means a positive correlation between salivary and blood glucose among diabetic and this correlation is statistically significant. There was no significant correlation between salivary and blood glucose among the control group, $r=0.1$ and the p-value is 0.48

Figure 1.



The ROC curve graph in figure 1 determine the cut-off point or value of blood glucose and salivary glucose levels, the ability to correctly diagnose diabetes or to detect glucose levels is more dominant with the blue line in the upper left corner of the graph “blood-sample”.

Whereas the green line “salivary-glucose” has less strength and ability than the blood-sample. Nonetheless, there are some elements to consider that may have had an influence and ma

nipulated the salivary glucose levels of the controlled participants the type of food, for example that the

participant eat the night before the collection of salivary that may have had an effect on the readings. Therefore, our outlook next is to see if these factors has a real effect to the reading or not.

DISCUSSION:

The correlation between the levels of salivary glucose and blood glucose has been conducted in many studies[5,6]. Diabetes mellitus is a chronic metabolic disorder that affect all age groups .This disease should be screened every day to control the glycemic state and nowadays estimating the elevated blood glucose is by the standard blood glucose technique but its invasive, venipuncture can cause atrophy in the areas of finer prick. This method should be replaced by applying a new noninvasive method such as the salivary glucose.

Our results showed a positive correlation between salivary glucose levels in uncontrolled [Diabetics] .These findings are similar to Satish Kumar , S . Padmashree [5] . we preformed the study among people with a sample size of 100 divided into fifty Controlled and fifty diabetics and in we found out that the salivary glucose was higher in diabetics than the control in fact, that both groups samples were taking while they were fasting at least eight hours and results showed a significant result ($P < 0.01$) as in Abikshyeet P et al [6] .In contrast, some of the studies showed negative correlation between Salivary glucose level and blood glucose level [7,8]. It was suggested that saliva cannot be implemented to indicate Blood glucose level in diabetics as the amount of damage to the salivary gland in turn the quantity of leakage of glucose from plasma to saliva is unpredictable [7]. Diabetic patient that participated in the study, their blood glucose level were uncontrolled with a mean of 199.58 mg

Our study is also concerned about the factors the influence the salivary glucose among both groups, results showed that there are some factors that can affect the concentration of the glucose in saliva such as specific food and the oral hygiene, we found that the majority of the controlled cases had elevated salivary glucose in contrast to the blood glucose, the type of food that was taken by the person before fasting at least 8 hours or food debris could have major influ-

ence on salivary glucose level. Factors like smoking and oral hygiene are challenges in the diabetic patients since they are more prone to develop oral ulcers than normal people, our result showed that the majority of the diabetics were smokers and that can affect their oral hygiene state. A study showed the majority of diabetics had oral ulcer last month as similar to a study performed by Hill et al. showed that un controlled DM patients are significantly more susceptible to have oral candidiasis which is similar to our study [9] . Other study by A polimeni et al regarding the oral state and salivary glucose demonstrated that oral hygiene care reduce salivary glucose in oral cavity which is supporting our hypothesis regarding the number of tooth brushing in the both groups[10].

Concerning the gender, our result found that female salivary glucose levels were much higher than the male level which had similar finding in María Elena et al [11] . Meanwhile a study by Percival et al[12] proposing that females salivary glucose level were lower than males, explaining that females had smaller salivary glands and also because of other hormonal factors like the loss of estrogen in post-menopausal women has lower flow salivary rate than in men. According to the International Diabetes Federation, 387 million people worldwide have diabetes and what is devastating is that more than 170 million people are not aware that they have diabetes[13], some study [14] is suggesting that it may be possible for the non-invasive painless technique to measure the glucose level and detect diabetes at an earlier time than the invasive method of taking a blood sample thus reducing the chances of complication that are sometimes are the first presentation of diabetes, moreover, younger patient will have the ability to screen for DM with less expensive and simple methods instead of blood withdraw. Children who have high salivary glucose level may have a major risk of having diabetes according to

In the study, we found out that one of major difficulties that diabetic patients faced are pain then the need of others for help to measure their blood glucose levels. However, we couldn't find another study that addressed this issue. Nonetheless its people who have no diabetes" the control" also has the same view that it would be easier for them if they have a family

member to measure their salivary glucose rather than pinprick every morning or when needed especially when they have to control and know about their blood glucose to avoid the terrifying long term complication of diabetes. Almost all of the participant want to make their device easier.

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