Correlation of Glucose Levels in Serum and Saliva: Determination of Incidence of Dental Caries and Periodontal Status in Patients with Diabetes Mellitus.

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ABSTRACT

Introduction: various oral diseases have been detected in diabetes mellitus patients mainly dental caries and periodontal diseases. Diabetes Mellitus reduced salivary secretion occured due to pronounced polyuria in non-controlled and inadequately controlled cases. Whole saliva can be collected non-invasively and by individuals with limited training. **Aim**: the present study was aimed to estimate and correlate the plasma and salivary glucose levels in diabetic and nondiabetic subjects, with special reference to age. Determination of salivary pH in diabetic and non-diabetic subjects and cmparison of the prevalence with an increased risk of dental caries and periodontal diseases. **Materials and Methods**: Study involved 40 subjects, distributed in two groups; (1) 20 non-diabetic subjects (control group) (2) 20 uncontrolled diabetic subjects. Fasting blood and saliva glucose levels and salivary pH for each subject were measured with the help of biochemical analyser

and digital pH meter, respectively. Caries index was recorded using decay, missing, filled, treatment (DMFT) index and periodontal diseases recording by periodontal disease index (PDI). **Results**: The salivary glucose levels were significantly higher in group 1 and group 2 diabetics when compared with controls. The salivary glucose levels show a significant correlation with plasma glucose levels between study populations, suggesting that salivary glucose levels can be used as a monitoring tool for predicting glucose level in diabetic patients. Decrease in the mean salivary pH of 6.51 in the study group, compared to the normal mean salivary pH of 7.88 in the control group. The mean DMFT index was higher in the study group (8.10) when compared to that of control group (1.15). The mean PDI score was also higher in the study group (4.0) as compared to that of the control group (0.45). **Conclusion**: saliva glucose can be used as an indicator for diabetes. There was a significant relationship between the diabetes mellitus and increased incidence of dental caries and periodontitis. There was also a significant reduction in the salivary pH in diabetes mellitus patients, compared to that of non diabetic subjects.

Key words: Diabetes mellitus, dental caries, periodontal disease, saliva pH and salivary glucose estimation.

الملخص

علاقة تركيز سكر الكلوكوز في المصل واللعاب، مقياس حامضية اللعاب، نسبة تسوس الاسنان و الحالة الصحية للثة وانسجة الفم عند مرضى السكري.

المقدمة: يعد مرض السكري مرض مزمن يؤثر على عدة اجزاء من الجسم، ان العديد من امراض الفم لها ارتباط بمرض السكري مع زيادة خطورة الاصابة بتسوس الاسنان وامراض اللثة. ان مرض السكري يمكن ان يؤدي الى نقص في افراز اللعاب بسبب زيادة عدد مرات الادرار في حالات السكر غير المنظمة بالعلاج. تهدف الدراسة الحالية الى حساب ومقارنة تركيز السكر في الدم واللعاب، مقياس حامضية اللعاب و نسبة حدوث وزيادة خطورة الاصابة بتسوس الاسنان والتهابات اللثة بين مرضى السكري وغير المرضى.

المواد والطرق: تشمل الدراسة 40 مريض مقسمين الى مجموعتين: المجموعة الاولى تضمنت 20 مريض غير مصابين بمرض السكري والمجموعة الثانية تضمنت 20 مريض مصابين بداء السكري. تم قياس نسبة السكر في الدم

واللعاب في وضعية الصيام وحامضية اللعاب لكل مريض، تم تحديد مقياس التسوس باستخدام معدل الاسنان المسوسة والمفقودة والمحشوة ومعدل التهابات اللثة.

النتائج: كان تركيز سكر الكلوكوز في اللعاب اكبر بشكل مؤثر عند مرضى السكري للنوعين الاول والثاني بالمقارنة مع غير المصابين. هنالك ارتباط وثيق بين تركيز سكر الكلوكوز في الدم مع تركيزه في اللعاب في مجموعتي هذه الدراسة مما يدل على امكانية استخدام تركيز الكلوكوز في اللعاب كوسيلة لمراقبة مستوى الكلوكوز عند مرضى السكري. كان مقياس حامضية اللعاب 6,51 لدى مرضى السكري بالمقارنة مع غير المصابين حيث كانت قيمة الحامضية 7,88. كان معدل الاسنان المسوسة والمفقودة والمحشوة يساوي 8,10 لدى مرضى السكري بالمقارنة مع غير المصابين حيث كانت قيمته هي 1,15 وكذلك الحال بالنسبة لمعدل التهابات اللثة الذي كانت قيمته 4،0 بالمقارنة مع 0.45.

الاستنتاج: مرض السكري واحد من الامراض الايضية المتضمنة لامراض الغدد اللعابية عن طريق تاثير الكثير من العوامل الداخلية والخارجية التي تؤدي الى خلل في تركيب ووظيفة اللعاب، خلل في حامضية اللعاب و التهاب اللثة الناتج عن تفاقم الاستجابة الالتهابية للنبيت المجهري في اللثة.

INTRODUCTION

Diabetes mellitus (DM) is associated with serious complications in the eyes, kidneys, heart and blood vessels, and other organ systems, these may markedly impair quality of life and shorten the patient's lifespan.[1] Many people are affected by diabetes worldwide and the number is climbing steeply. [2] It is also probable that (DM) is the most frequent metabolic disease with salivary implications. Salivary hypofunction and increased susceptibility to oral infections as caries or periodontitis have long been recognized in this disease [3], particularly when there has been dehydration and inadequate glucose ($C_6H_{12}O_6$) blood control. However, there is non adequate knowledge concerning the true effects of diabetes on salivary and oral parameters of well-controlled patients and the way that the disease affect the patients.[4] The current concept in diabetic care is through the blood glucose monitoring frequent use of short-acting insulin or oral hypoglycemic and a restricted diet.[5] However, there are many internal and external factors that contribute to DM and in turn affect the general health and more so oral health.[6] Diabetes mellitus alter the salivary composition and functions. Change in oral environment initiates pathogenic bacteria, damaging hard and soft tissues of the oral cavity leading to an increased cariogenic activity and periodontal lesions. Saliva provides a protective effects, hence can be development of dental caries when there is clinically significant decrease in salivary functions.[7] Alterations in pH of the saliva are often reported in diabetes mellitus patients. A correlation between pH changes in plaque and sugar clearance from saliva.[8] The low salivary pH provides an acidogenic environment for the growth of cariogenic acidemic bacteria leading to dental caries which again further lowers the salivary pH leading to a vicious cycle. Diabetes promotes periodontitis through an exaggerated inflammatory response to the periodontal microflora.[9] Periodontal disease, which is one of the most common dental problems and a major cause of tooth loss, is caused

by a variety of oral plaque bacteria.[10] The present study was aimed to estimate and correlate the plasma and salivary glucose levels in diabetic and nondiabetic subjects, with special reference to age, determination of salivary pH in diabetic and non-diabetic subjects and cmparison of the prevalence with an increased risk of dental caries and periodontal diseases.

MATERIALS and METHODS

A cross-sectional study was conducted in the Department of Dentistry, Ibn Hayyan University College from January to March 2017 a total of forty (40) subject (age ranges 20-40) male and female, were included after taking the institutional ethical clearance and informed consent from the samples. Subjects were divided into two groups. Group 1 (study group) comprised twenty (20) known diabetic patients, with a fasting blood glucose more than 120mg/dl, with at least two years of (DM) duration. Both the Type I and Type II diabetic patients were included in this group. Group 2 (control group) comprised twenty (20) non diabetic patients, which were age and gender matched to diabetic group. A detailed history of the patient was taken including personal history, drug history, allergies. Patients were clinically examined and assessed for dental caries and periodontal status using the Decay, Missing, Filled, Treatment (DMFT) index and the Periodontal Disease Index (PDI) respectively. Blood samples were collected for estimation the fasting blood glucose levels. The unstimulated whole salivary samples were collected from subjects in both groups by spitting method, after a waiting period of 10 minutes, so as to avoid sample dilution before collection. Subjects were asked to bend the head forward and accumulate the saliva in the floor of the mouth and expectorate it in a sterile container, every five minutes for15 minutes. The pH of the samples was immediately analyzed using a pH meter.

Serum and salivary glucose determination

Estimation of serum and salivary glucose levels were done by the use of an enzymatic colorimetric test kit, by GOD-POD method (glucose oxidase-peroxidase method). (Glucose Kit, Erba Mannheim, Trinder's Method, Transasia Biomedical Ltd., HP, India).

Statistical analysis

By using the statistical package for social sciences (SPSS) program version 20, data were entered and analyzed with appropriate statistical tests. Descriptive statistics were presented as frequencies, proportions, mean and standard deviation (SD). Paired t test was used to compare pre and post -operative mean VAS scores and Fisher's exact test was used to compare frequencies (proportions). Level of significance (P value) ≤ 0.05 considered as significant, and ≤ 0.001 considered as highly significant. Finally all findings and results are presented in tables and/or figures with explanatory paragraphs accordingly.

RESULTS

In the present study, 20 diabetic (study group) and 20 non-diabetics (control group) subjects were participated. [Table1]. Mean fasting blood sugar (FBS) level in the diabetic patients group was higher (167.06 ± 57.24 mg/dl) than in healthy patients group (78.94 ± 16.70 mg/dl). Mean average plasma glucose in diabetic patients was (234.11 ± 65.33 mg/dl) compared to healthy group (105.20 ± 24.77 mg/dl). Similarly, the mean salivary glucose was higher in the diabetic patients group (13.96 ± 7.09 mg/dl) than in healthy patients (4.61 ± 2.58 mg/dl) .Thus, salivary glucose was higher like higher FBS, and average plasma glucose level was higher like higher FBS, and average plasma glucose level was in diabetic patients than in healthy persons. [Table 2] depicts the comparison of mean salivary pH, DMFT and

PDI among diabetic patients and non-diabetic patients, the salivary pH was low (6.5 ± 0.71692) among the study group compared to the control group (7.89 ± 0.279117) and the mean DMFT (8.1 ± 5.875) and PDI (4±1.589) score were high in diabetic patients than non-diabetic patients whose DMFT and PDI score were (1.15 ±1.641) and (0.45±0.605) respectively. Independent sample t-test showed that there was a highly significant difference in the mean score between the study group and the control group, with a p-valve of <0.05, which was statistically significant.

Table 1 Inter group comparison of different variables like average plasma glucose, FBS, salivary glucose in diabetic patients and healthy patients.

variables	Group	No.	Mean	SD	P value	Results
Average plasma glucose (mg/dl)	Diabetic patients	20	233.11	66.33	<0.001	s
	Healthy group	20	104.19	23.78	<0.001	s
FBS (mg/dl)	Diabetic patients	20	166.07	57.24	<0.001	s
	Healthy group	20	78.93	16.71	<0.001	s
Salivary glucose (mg/dl)	Diabetic patients	20	13.95	7.09	<0.001	s
	Healthy group	20	4.51	2.68	<0.001	s

Table 2 Comparison of mean salivary pH, DMFT and PDI between Diabetic and Non- Diabetic Patients.

Parameter	Group	N	Mean	SD	P value
Saliva PH	DM	20	6.5	0.716	<0.001
	NDM	20	7.99	0.279	<0.001
DMFT	DM	20	8.1	5.875	<0.001
	NDM	20	1.25	1.461	<0.001
PDI	DM	20	4	1.589	<0.001
	NDM	20	0.45	0.605	<0.001

(p<0.05 – Statistically Significant)

DISCUSSION

Diabetes mellitus (DM) is a common chronic metabolic disease with numerous oral and systemic manifestations. They include dental caries, salivary dysfunction, oral mucosal and other oral infections, taste and neurosensory disorders, gingivitis, periodontitis. [11] This study evaluated the salivary pH and its effect on dental caries and periodontal status of (DM) patients and compared them with normal subjects. [8] In the oral cavity, the pH remained near neutrality (6.8-7.2) by saliva. The saliva maintains the pH by two mechanisms: First mechanism is the flow of saliva eliminates the carbohydrates which could be metabolized by the bacteria hence the acid produced by the bacteria is removed. Second mechanism through the buffering activity of saliva that neutralizes the acidity formed by food and drinks, as well as from the microbial activity. [8] The mean salivary pH was compared between diabetics and control group. Diabetes mellitus samples had lowering salivary pH when compared to that of control group [Table 1]. This decrease is attributed to the metabolic changes in diabetes mellitus patients resulting in acidic pH. In diabetes, there is reduction in the level of bicarbonates in all body fluids which leads to metabolic acidosis of all body fluids. This explains the acidic nature of the saliva in patients with diabetes mellitus. [12] Abikshyeet et al. (2012) in his study similar to our study showed a salivary glucose levels increase as plasma level increased.[13] López et al (2003) showed that the salivary glands act as filters of blood glucose which may be altered by hormonal or neural regulation. [14] According to Qureshi et al. (2007) there is an increased leakage of glucose from the ductal cells of the salivary gland, so salivary glucose level is increased in diabetic patients.[15] This is due to microvascular changes in blood vessels and change in the basement membrane in diabetic patients. Hyperglycemia caused increased formation of advanced glycosylation end (AGEs) products. These AGEs products crosslink proteins such as collagen and extracellular matrix proteins, leading to basement

membrane alteration and endothelial dysfunction, which makes them more permeable.[16] This is supported by Belazi et al. who proposed that the increased permeability of basement membrane in diabetic patients may lead to enhanced leakage of smaller molecules like glucose into whole saliva via gingival crevices. [17] Patients with diabetes mellitus had increased DMFT score when compared to the control group [Table 1]. This is due to loss of protective mechanism of the saliva in diabetics. The cleansing and buffering action of saliva is also impaired. Low salivary pH promotes the growth of aciduric bacteria which then allows the acidogenic bacteria to proliferate creating an inhospitable environment for the protective oral bacteria. This allows for a shift in the oral environmental balance to favour cariogenic bacteria, which further lowers the salivary pH and the cycle continues. [18] Cariogenic bacteria are likely to thrive in acidic environment. Other risk factors such as increased blood glucose levels, reduced salivary flow rate, buffering capacity, poor dietary control also increases the risk of dental caries in diabetes mellitus patients. The present study is in accordance with studies done by Deepak Goyal et al., Ciglar et al., Rai K et al., Elkafri et al., who all have reported decreased salivary pH and increased dental caries among diabetes mellitus patients [18, 19] When the periodontal status was compared, patients with diabetes mellitus had increased occurrence of gingivitis and periodontitis than the non-diabetic control group [Table 2]. Diabetes increases the risk of gingivitis and periodontitis. One of the major complications of diabetes is change in the microvascular integrity. In (DM), chronic and prolonged hyperglycaemia leads to high levels of accumulation of irreversibly glycated proteins called Advanced Glycation End Products (AGEs) in the tissues including periodontium. This results in compromised wound healing and increased periodontal tissue destruction in diabetes mellitus patients. This study is in accordance with study done by Poplawaska-Kita et al., who reported that there was an increased risk of periodontitis in patients with diabetes mellitus[20] Also, the reduction in salivary pH

which was evident in our study may increase the growth of periodontal-pathogens which is in accordance with that of Takahashi et al., Fujikawa et al., and Galgut. [21, 22] Negative correlation was found between salivary pH and DMFT and between salivary pH and PDI, [Table2] which suggests that when the pH of the saliva is decreased (acidic), there is increased incidence of dental caries. This result is in accordance with the study done by Michelle Hurlbutt et al., who reported that low salivary pH promotes cariogenic lesions in the oral cavity. [23] Similarly, pH of saliva in patients with periodontitis is more acidic than control group [Table2], which is similar to the study done by Sharmila Baliga et al., who reported that pH of saliva in patients with chronic generalized periodontitis was more acidic than pH of saliva of the control group[8] This can be explained in accordance with the study conducted by Takahashi et al., that the microorganism which are responsible for periodontitis have a favourable environment for growth in an acidic pH such as *P. gingivalis* grows at a pH of 6.5-7.0, P. *intermedia* grows at a pH of 5.0-7.0 and *F. nucleatum* grows at a pH of 5.5-7.0 [23] Saliva glucose can be used as an indicator for diabetes. The present method of blood glucose estimation needs the venepuncture, which may be traumatic to the patients at times, especially to the children. Apart from physical trauma, process also renders mental trauma and anxiety about the procedure to discourage the patients further making the blood glucose analysis more acceptable to the patients which will not hamper their regular visit to diabetic clinics. It might be time to establish the method that will non-invasively measure blood glucose level. Author aimed to evaluate the correlation between BGL and SGL, that will enable to discuss whether SGL correspond to BGL or not. The important criterion to choose the glucose in saliva to measure the blood glucose is that, saliva is said to be the ultra filtrate of blood. Glucose is one of the blood components that are transferable across the salivary gland epithelium in proportion to its concentration in blood. Secondly, whole saliva is the biologic fluid that is simple to collect. [16]

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