Journal of Diabetes and Obesity

OMMEGA Publishers
Answering Intelligence

Research Article | Open Access

Association of Salivary & Plasma Glucose Level with Oral Health Status among Type 2 Diabetics in India - A Comparative Study

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Abstract

Background and Objectives: Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the condition. Biochemical analysis of saliva would be of great biomedical importance, since saliva is very easy to collect offering a cost-effective approach for screening of large populations, and could represent an alternative for the patient whose blood is difficult to obtain when compliance is a problem. The objective of the study was to correlate blood glucose level and salivary glucose level with oral health status among type 2 diabetic and non-diabetics.

Methodology: Cross sectional study was conducted among 130 diabetic patients and 130 non-diabetic individuals attending premier medical institutions in Bhopal. 2ml of peripheral blood was collected for the estimation of random non fasting plasma glucose levels. Unstimulated saliva was collected for the estimation of salivary glucose.

Results: Salivary glucose levels were significantly higher in patients with diabetes than controls. There was a significant positive correlation between salivary and plasma glucose levels in patients with diabetes suggesting that salivary glucose levels can be used as a monitoring tool for predicting glycemic control in diabetic patients.

Conclusion: Salivary glucose levels can be used as a noninvasive, painless technique for the measurement of diabetic status of a patient in a dental set up.

Received date: February 02, 2017
Accepted date: March 03, 2017
Published date: March 08, 2017

Citation: Dwivedi.A., et al. Association of Salivary & Plasma Glucose Level with Oral Health Status among Type 2 Diabetics in India - A Comparative Study. (2017) J diab Obes 4(2): 1- 7.

DOI: 10.15436/2376-0494.17.1378

Keywords: Salivary glucose levels; Diabetics; Type 2 diabetes mellitus

Introduction

Diabetes mellitus is a group of chronic conditions characterized by insulin deficiency, cellular resistance to insulin action, or both, resulting in hyperglycemia and other related metabolic disturbances. The condition is associated with serious complications of various organ systems of the body which might markedly impair quality of life and shorten the patient's lifespan. Diabetes is a massive, silent growing epidemic that has a potential to cripple health services in all parts of the world. Several soft tissue abnormalities have been reported to be associated with diabetes mellitus in the oral cavity. These complications include periodontal diseases, salivary dysfunction leading to reduction in salivary flow and changes in salivary composition and taste dysfunction. Oral fungal and bacterial infections have also been reported in patients with diabetes[1-4]. There are also reports of increased prevalence of oral mucosal lesions including, lichen planus, lichenoid reaction angular chelitis, mucosal neuro-sensory disorders and dental caries compared to healthy controls[5-7].

Biochemical analysis of saliva would be of great biomedical importance, since saliva is very easy to collect offering a cost-effective approach for screening of large populations, and could represent an alternative for the patient whose blood is difficult to obtain when compliance is a problem[8].

There are no studies reported from Madhya Pradesh to date regarding oral health status correlating with salivary glucose level of Type 2 Diabetes mellitus patients. Hence the present study was conducted to assess salivary glucose levels and to

correlate this with oral health status in Type 2 diabetic patients and non-diabetics in Bhopal city. The aim of the present study is to assess salivary glucose levels and to associate with oral health status among type 2 diabetes mellitus patients and non-diabetic subjects attending premier medical centers of Bhopal city, Madhya Pradesh.

Methodology

The study was approved by Institutional Ethical Committee (Project code 2014PHD02) and written informed consent was obtained from study participants before examination. A pilot study was carried out among 30 diabetic patients, mainly to assess the feasibility of study. A total of 260 subjects in the age group of 30 - 82 years were examined with 130 diabetic patients considered as cases and an equal number of non-diabetics taken as comparison group.

All known type 2 diabetic patients who were willing to participate with written informed consent were included in the study. Patients with any medical condition including diabetes mellitus contraindicating oral examination without appropriate medication, patients with any other systemic disease or recent history of medication which affect oral microflora and salivary flow were excluded.

Examination was done in the examination room / out patient department of the Hospital with the aid of a mouth mirror and CPI probe under adequate natural light. Unstimulated saliva sample was collected for salivary glucose estimation. All salivary samples were collected 2 hours after breakfast using 'spit technique'. The patient was asked to sit and head tilted forward and instructed not to speak or do any head movements (or swallow any saliva if present in the mouth) during the procedure. Then the patient was instructed to spit in a sterile graduated container (which preserves saliva for up to 3 hours) every minute for 10 minutes[9].

Salivary glucose level was measured using the glucose oxidase method in a semi-automated analyzer. The saliva sample (100 microl) was mixed with the reagent (glucose oxidase) in 1: 3 ratio and incubated for 5 min at 37°. The absorbance values of standard and the sample against the reagent black was measured. The glucose standard was diluted 10 times for estimation of salivary glucose. This method was standardized and could measure a minimal salivary glucose concentration of 0.2 mg/dl[9].

The data collected was entered in SPSS (Statistical Package for the Social Sciences) version 22.0, for the purpose of data analysis. Chi-square test, t-test and Spearman test were applied to compare quantitative data and determine the statistical significance. p value < 0.05 was considered to be statistically significant.

Results

The mean age of diabetics was 50.59(± 11.36) years, while mean age of non - diabetics was 49.45 (± 10.12) years. A total of 70 (53.8%) males and 60 (46.2%) females comprised the sample of cases while in controls, 66 (50.8%) males and 64 (49.2%) females were present. Among Cases and Controls 53 (40.8%) & 42 (32.3%) had vegetarian diet respectively and remaining had mixed diet. Majority of the population in both the groups did not take fruit but consumed junk food or soft drinks with 84 (64.6%), 127 (97.9%), 128 (98.5%) in cases and 95 (69.3%), 112 (81.8%), 121 (88.3%) in controls respectively (Table 1).

Table 1: Percentage distribution of Cases and Controls according to demographic details, food habits, adverse habits and Alcohol.

		Cases	Controls
		Frequency (%)	Frequency (%)
Age (years)	**Less than 50 years**	74(56.9)	75(57.7)
	More than 50 years	56(43.1)	55(42.3)
Gender	**Male**	70(53.8)	66(50.8)
	Female	60(46.2)	64(49.2)
Marital Status	**Staying Single**	12(9.2)	12(9.2)
	Married	118(90.8)	118(90.8)
Type of food	**Vegetarian**	53(40.8)	42(32.3)
	Mixed	77(59.2)	88(67.7)
Fruit consumption / week	**0**	84(64.6)	95(69.3)
	1 to 5	30(23.1)	26(19)
	More than 5	16(12.3)	9(6.6)
Junk Food consumption / week	**0**	127(97.9)	112(81.8)
	1 to 5	3(2.3)	17(12.4)
	More than 5	0(0)	1(0.7)
Soft drink consumption / week	**0**	128(98.5)	121(88.3)
	1 to 5	2(1.5)	8(5.8)
	More than 5	0(0)	1(0.7)
Habits	**No smoking**	93(71.5)	67(51.5)
	Smoking form of tobacco	10(7.69)	17(13.1)
	Smokeless form of tobacco	27(20.7)	37(28.5)

	Both	0(0)	9(6.9)
Age of onset	**Before 20 years of age**	12(32.4)	19(29)
	Between 21 to 30 years	17(45.9)	30(48.4)
	After 30 years of age	8(21.6)	14(22.6)
Frequency of Tobacco consumption (Smoking form)	**Less than 5**	3(30)	9(34.6)
	6 to 10	5(50)	9(34.6)
	More than 10	2(20)	8(30.8)
Frequency of Tobacco consumption (Smokeless form)	**Less than 5**	16(59.3)	34(73.9)
	6 to 10	11(40.7)	11(23.9)
	More than 10	0(0)	1(2.2)
Alcohol consumption	**Yes**	8(6.2)	11(8.5)
	No	122(93.8)	119(91.5)

* p- value < 0.05, ** p-value < 0.01.

While recording the habits in diabetic patients (cases), 71.5% were having no history of any kind of habits where as 7.6% of cases were taking smoking form of tobacco and 20.7% were having smokeless form of tobacco. Among the controls too, majority of them (51.5%) did not have any kind of habits where as 13.1% were taking smoking form of tobacco and 28.5% were having smokeless form of tobacco and 6.9% were having both type of habits. In case of alcohol consumption, majority of the cases 93.8% and controls 91.5% belonged to the non-alcoholic group (Table 1) 86.2% of cases and 84.6% of controls never visited the dentist whereas 13.8% of cases and 15.4% of controls visited dentist in past 1 year.79.2% cases replied that they used tooth brush, 18.5% used their finger while 2.3% used Datun for cleaning. More number of controls (89.2%) used tooth brush as cleaning aids. Regarding the material used for cleaning teeth it was seen that 88.5% cases and 92.3% of controls used tooth paste. When cases and controls were asked the frequency of brushing, majority of cases 109 83.8% & 97.7% replied that they cleaned their teeth only once in a day. (Table 2)

Table 2: Percentage distribution of Dental utilization & Oral Hygiene Aids used among Cases and Controls.

		Cases		**Control**	
		Frequency (n)	**Percent %**	**Frequency (n)**	**Percent %**
Dental utilization	**Yes**	18	13.8	20	15.4
	No	112	86.2	110	84.6
Type of Cleaning	**Brush**	103	79.2	116	89.2
	Finger	24	18.5	13	10
	Datun	3	2.3	1	0.8
Material used	**Tooth paste**	115	88.5	120	92.3
	Tooth powder	14	10.8	10	7.7
	Charcoal	1	0.8	0	0
Frequency of Cleaning	**Once a day**	109	83.8	127	97.7
	Twice a day	21	16.2	3	2.3
	Some times a week	0	0	0	0

* p- value < 0.05, ** p-value < 0.01

Among diabetic patients, majority of the patients 90 (69.2%) had diabetes for less than 5 years while only 4 (3.1%) had diabetes for more than 15 years. Majority of these patients 88.5% had no family history of diabetes mellitus with the remaining 11.5% having family history of diabetes. Out of 130 diabetic patients, 60.8% patients were on insulin whereas 39.2% were taking oral hypoglycemic drugs for the treatment of diabetes mellitus. Apart from drugs for diabetes mellitus 21.5% of them were taking antibiotics and/or any other drugs and in controls, 76.2% were not taking any kind of drugs. The mean values for Random plasma glucose level in diabetic patients and in controls was 212.63 (± 75.47) and 95.18(± 13.44). The mean Salivary Glucose Level among diabetic patients was 10.56 (± 4.51) with 42 (32.3%) of them having more than 13.3 mg/dl of Salivary Glucose Level. (Table 3)

Table 3: Percentage distribution of Cases according to Diabetic history, medication taken, random plasma glucose level and salivary glucose level

			Cases	Control
			Frequency (%)	Frequency (%)
Duration	**Less than 5 Years**		90(69.2)	
	6 to 10 years		21(16.2)	
	11 to 15 years		15(11.5)	
	More than 15 years		4(3.1)	
Family History	**Yes**		15(11.5)	
	No		115(88.5)	
Treatment	**For diabetes Mellitus**	**Insulin**	79(60.8)	
		Oral Hypoglycemic drug	51(39.2)	
	Antibiotics/ Any other	**Yes**	28(21.5)	31(23.8)
		No	102(78.5)	99(76.2)
Random plasma glucose level	**Less than or equal 120 mg/dl**		3(2.3)	124(95.4)
	121 to 200 mg/dl		70(53.8)	6(4.6)
	More than 200 mg/dl		57(43.8)	0(0)
Salivary Glucose Level (mean- 10.56 ± 4.51)	**Less than 4.1 mg/dl**		1(0.8)	0(0)
	4.2 to 13.3 mg/dl		87(66.9)	0(0)
	More than 13.3 mg/dl		42(32.3)	0(0)

Majority of the diabetic patients, 61.5% had less than 4 decayed teeth, whereas among controls, 83.1% had less than 4 decayed teeth. Majority of Diabetic patients 56.2% had less than 4 missing teeth in their dental arch, whereas in controls majority of individuals (66.2%) had no missing teeth in their dental arch. Both the groups were assessed for their periodontal status using CPI Index. In Diabetic patients the mean number of sextants with score 0, score 1, score 2, score 3 and score 4 was 0.74 (± 1.79), 0.56 (± 1.37), 2.68(± 2.17), 1.96 (± 2.14) and 0.03 (± 0.26) respectively whereas in controls the mean number of sextants with score 0, score 1, score 2, score 3 and score 4 was 0.32 (± 1.28), 2.70 (± 2.47), 2.36 (± 2.07), 0.58 (± 1.05) and 0.02 (± 0.15) respectively (Table 4)

Table 4: Percentage distribution of Caries Experience & CPI Score for the Study Groups.

	Cases	Control	p-value
	Frequency (%)	Frequency (%)	
DECAYED			
No Decay tooth	25(19.2)	14(10.8)	
Less than 4 Decay tooth	80(61.5)	108(83.1)	
More than 4 Decay tooth	25(19.2)	8(6.2)	
MISSING			
No Missing tooth	54(41.5)	86(66.2)	
Less than 4 Missing tooth	73(56.2)	44(33.8)	
More than 4 Missing tooth	3(2.3)	0(0)	
FILLED			
No Filled tooth	118(90.8)	121(93.1)	
Less than 4 Filled tooth	12(9.2)	9(6.9)	
More than 4 Filled tooth	0(0)	0(0)	
CPI score			
0	0.74 (1.79)	0.32 (1.28)	0.03*
1	0.56 (1.37)	2.70 (2.47)	0.00**
2	2.68 (2.17)	2.36 (2.07)	0.22
3	1.96 (2.14)	0.58 (1.05)	0.00**
4	0.03 (0.26)	0.02 (0.15)	0.56

* p-value < 0.05, ** p-value < 0.01

Spearman Correlation showed that Salivary Glucose Level and Random plasma glucose level were significantly associated ($p < 0.01$) with each other (Table 5)

Table 5: Correlation of Salivary Glucose Level and Random plasma glucose level among cases.

	Salivary Glucose Level	Random plasma glucose level
Salivary Glucose Level	1	0.00**
Random plasma glucose level	0.00**	1

Spearman Correlation
** p-value < 0.01

Binary logistic regression analysis with demographic details & habits as Independent variables on diabetes mellitus showed that the socioeconomic status, fruit consumption/week, junk food consumption/week, type of adverse habits, smoking form of tobacco, smokeless form of tobacco, activity at work, recreational activity, travel to and from places was significantly associated with random plasma glucose level ($p < 0.05$) (Table 6)

Table 6: Binary logistic regression analysis with demographic details & habits as Independent variables and diabetes mellitus as dependent variable.

Factor	E x p (B) odds ratio	95.0% C.I. for EXP(B)		P value
		Lower	Upper	
Age	0.98	0.96	1.01	0.41
Gender	1.17	0.68	2.00	0.55
Socioeconomic status	0.67	0.47	0.95	0.02**
Marital status	1.86	0.78	4.43	0.15
Type of diet	1.19	0.68	2.08	0.53
Fruit consumption/week	0.44	0.27	0.72	0.00**
Junk food consumption/week	10.37	2.70	39.71	0.00**
Soft drink consumption/week	3.09	0.66	14.32	0.14
Type of Adverse habits	33.11	10.73	102.09	0.00**
Age of onset	0.75	0.36	1.55	0.43
Smoking form of tobacco	0.18	0.09	0.33	0.00**
Smokeless form of tobacco	0.04	0.01	0.11	0.00**
Alcohol	0.17	0.02	1.25	0.08
Activity at work	3.70	2.10	6.54	0.00**
Recreation activity	0.33	0.17	0.61	0.00**
Travel to and from places	0.08	0.02	0.25	0.00**

* p- value < 0.05, ** p-value < 0.01

Discussion

The prevalence of dental diseases and its burden on the general population is of significant public health importance. Diabetes Mellitus, a significant public health problem in its own right, may increase one's susceptibility to dental diseases. Therefore, the present comparative study was conducted to assess and compare dental diseases of diabetic patients with that of no diabetics[11-14].

To the best of our knowledge, no study has been reported from Central India, although literature is available regarding prevalence of diabetes mellitus for North Indian region, making it a pioneer study of Central India. In present study majority of the cases (93.8%) and control (91.5%) belonged to the non-alcoholic group and similar results were found in the study done by Siraj Ahmad[10] where 85.5 % belonged to the non-alcoholic group. In the present study analysis showed, high of junk food consumption, less frequency of fruit consumption, use of both forms of tobacco that is (smoking form and smokeless form) & reduced physical activity at work and travel were the risk factors for developing Diabetes mellitus, similar to the results by Valliyot Balakrishnan., *et al*.[15] Majority of the cases in the present study had the history of diabetes since 5 years (69.2%) and a positive family history for type 2 diabetes was found among 11.5% cases, whereas in a study by B. Valliyot., *et al*[15] 55.0% of cases had a family history of DM. According to a report by WHO[16], it has long been known that T2D is, in part, inherited.

Spearman Correlation showed that Salivary Glucose Level and Random plasma glucose level were significantly associated ($p < 0.01$) with each other. A higher but statistically not significant random plasma and salivary glucose levels among cases than controls were found in a study by Hegde., *et al*[17], Vaziri., *et al*[18]. This difference in the results may be due to diversity in the study design as well as diabetic status and glycemic control, although the study could not establish a positive correlation between salivary and blood glucose in diabetics similar to that of Carolina., *et al*[19] and Forbat., *et al*.[20].

Regarding past dental visit, a similar percentage of participants in cases and controls had visited the dentists ie. 13.8% and 15.4% respectively whereas study done by Aija., *et al*[21] in which 69% of subjects had a dental appointment. Mean number of decayed teeth among cases were 2.79 in comparison to 2.2 in controls. Mean decay value in diabetic and non-diabetic patients in studies by Sukminingrum, N., *et al*[22] and Patino Marin, N., *et al*[23] were higher than the present study with mean values of 6.71 and 3.81 respectively. According to the National Oral Health Survey & Fluoride mapping 2002 - 2003, the adult population of Bhopal city (Region wise data) showed the mean number of decayed teeth to be 3.2, missing teeth 1.8 among 35 - 44 years age group whereas among 65 - 74 years age group the mean number of decayed teeth was 2.0 and missing teeth was 12.5[25].

Uncontrolled diabetes can lead to periodontal problems. Among diabetic patients, the mean number of sextants with score 3 and score 4 was 1.96 (± 2.14) and 0.03(± 0.26) respectively whereas in controls the mean number of sextants with, score 3 and score 4 was 0.58 (± 1.05) and 0.02 (± 0.15) respectively. Similar results were found in the previous study by Patino Marin, N., *et al*[23] with pocket depth of 4.4 (± 1.7) in cases and 2.6 (± 0.6) in controls. Leung., *et al*[24] found more than half of his cases with a CPI score of 3 and 4.

In present study statistically significant difference ($p < 0.01$) was seen between healthy periodontium, bleeding on probing and pocket depth 4 - 5 mm on comparing the groups of patients with diabetes mellitus to the control group. According to the National Oral Health Survey & Fluoride mapping 2002-2003, regional data showed similar results[25]. Mean number of

sextants with loss of attachment score of 6-8 mm in cases and controls was 2.77 (± 2.21) and 3.19 (± 1.92) respectively, similar to study by Leung *et al*[24] but higher compared to study by Patino Marin., *et al*[23].

Many developing countries are reporting the onset of type 2 diabetes at an increasingly younger age. This trend towards younger age of onset implies a huge additional burden to the individual's and society and necessitates a lifetime approach to prevention.

There are definite changes in salivary composition, with increased levels of salivary glucose in T2DM patients compared to the healthy controls and further significant positive correlation was seen between the serum and salivary glucose levels in the T2DM patients[26-30]. The levels of glucose in serum of T2DM patients could be reflected in saliva; hence we can conclude that the detection of diabetes can be performed by measuring the salivary glucose levels. This study can be taken as a stepping stone for establishing accepted reference values for salivary glucose for the population, with salivary samples serving as a noninvasive specimen for the detection of diabetes in the future.

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