Clinical and Sonographic Changes of Parotid Gland in Patients with Type I and Type II Diabetes Mellitus and ItsEffect on Physical Properties of Saliva

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ABSTRACT

Background:Sialosis is described as a specific consequence of diabetes. In diabetic sialosis, the increased volume of the glands is due to the infiltration of adipose in the parenchyma. The B-scan ultrasonography is a generally accepted tool for determining parotid gland enlargement. Oral health is, to a greater extent, dependent on quality and quantity of saliva, both of which may be altered in diabetics. This study was conducted to detect the enlargement of parotid gland in diabetic patient and study the changes in physical properties of saliva and its relation with the salivary gland enlargement.

Subjects, Materials and Methods: This cross-sectional study included subjects of both sexes attending Al-Yarmouk teaching hospital (Al-Yarmouk center for Diabetes), their ages ranged from20 to 65 years. Parotid gland was measured by using B-mode ultrasonography with a high frequency (6-9MHz). The Physical properties of saliva that were measured were flow rate, pH, and viscosity.

Results: The statistical analysis showed that: The right-left mean difference in length, width, depth and volume ultrasonography measurements of parotid gland among diabetic study group, revealed statistically non-significant difference, similar result was obtained among control group. The effect of Diabetes mellitus is marked on the parotid gland measurements as the disease progresses and the HbA1c increase. Physical properties of saliva give obvious decrease in flow rate and pH in diabetic patient while the viscosity was increased in diabetic rather than normal.

Conclusion: This study concludes that there is positive correlation between the progressions of disease and salivary gland measurements. On the other hand, the present article shows that there is negative association between flow rate, pH, and viscosity in comparison with salivary gland measurements.

Key words: Sialosis, parotid gland, Diabetes mellitus, ultrasonography. **(J BaghColl Dentistry 2016; 28(4):96-102)**

INTRODUCTION

Parotid gland (PG) is the largest of the major salivary glands (SGs) [(1)]. Sialosis can be described as a multifactorial disease of the salivary glands which is characterized by a painless bilateral growth. This growth is commonly seen in parotid gland and followed by a decreased salivary production which invariably leads to xerostomia.

Diabetes Mellitus (DM) is probably the most frequent metabolic disease with salivary implication [(2)].Diabetes is a widespread metabolic disease causing well-documented deleterious effects on the general health of an individual [(3)]. Multiple epidemiologic studies have suggested that diabetes is a risk factor for the development of oral disease in humans [(4,5)]. About a third of diabetic patients complain of dry mouth (xerostomia) which may be due to overall diminished flow of saliva resulting from systemic dehydration and an increase in the salivary glucose level [(6)].

Ultrasound (US) High-resolution B-scan sonography has become an approved method in head and neck imaging. Although widely used, no standard measurements for the sizes of parotid in B-scan sonography exist.

It is a noninvasive investigation which uses a very high frequency (7.5MHz) pulsed US beams rather than ionizing radiation to produce high resolution images of more superficial structures [(7)].Saliva is essential biological oral fluid which plays a crucial role in maintaining homeostasis of the oral cavity. Oral health is to a greater extent dependent on quality and quantity of saliva, both of which may be altered in diabetics.

This study was conducted to detect the enlargement of parotid gland in diabetic patients and study the changes in physical properties of saliva to the relation with the salivary gland enlargement.

SUBJECTS AND METHODS

This cross-sectional study included 102 subjects attending Al-Yarmouk teaching hospital (Al-Yarmouk center for Diabetes). The age range of the patients was 20-65 years. The total sample was divided into 3 groups: Control group, study group1 with type I DM, study group 2 with type II DM.

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All patients with sialoadenosis caused by other endocrine diseases, nutritional disorders or neurogenic and sympathomemetic medications [8] were excluded from this study, also smokers and those subjects whose weight exceeded 20% of the Ideal Body Weight (IBW) according to Broca's formula IBW= (height-100) [9], were excluded.

Assessment of DM patients from normal

1. Clinical assessment by specialist of endocrine diseases.
2. Fasting plasma glucose (FPG) test: This test was done in (Al-Yarmouk center for Diabetes) laboratory for study group and control group to ensure that all subjects in control group were free from disease.
3. Glycosylated hemoglobin A1C test (HbA1c): This test was performed for both study groups to assess the degree of control in diabetic patients. according to the American Diabetes Association **ADA** [10], Patients were considered to have an optimal diabetic control when the HbA1c value did not exceed 7%, a moderate or acceptable control for values up to 7.9% while patients who had HbA1c values of 8%-9.5% were considered to have poor control.

Ultrasound investigation of the parotid gland:

A complete ultrasound B-scan investigation of the head and neck was done, using a modern ultrasound device (FUKUDA DENSHI) with a multifrequency transducer. The PG was measured according to the protocol set forth by Dost [11] and Bozzato[12]in length, width and depth. The length was measured in a transverse plane, the width in a ramus-parallel plane. The depth was recorded as the mean of the measured superficial and deep parts of the gland. Distinctive features in the sonographic texture were also documented separately.

The volume was determined by multiplying the length by width by mean of depth by the correction factor 0.8[12].

Gland volume = length (mm)×width (mm) × depth(mm)× 0.8

Examination of physical properties of saliva:

Unstimulated whole saliva samples were collected by asking the subjects to refrain from eating, drinking or oral hygiene procedures for at least one hour before the collection. Each subject was instructed to wash and rinse his mouth with water several times to ensure the removal of any possible food debris and contaminating materials and asked to accumulate saliva in their mouth by spitting into graduated glass tube.

The salivary flow rate was calculated by dividing the volume of collected saliva (ml) by the time required for the collection in minute [13-15]then the salivary pH was measured by pH meter (Jenway 3320)and the viscosity of saliva measured by digital rotary viscometer(Figure 1).

Statistical analysis

Data were translated into a computerized database structure. Statistical analyses were done using SPSS version 21 (Statistical Package for Social Sciences). Frequency distribution for selected variables was done first.

The outcome quantitative variables in the current study were normally distributed variables and were therefore conveniently described by mean, SD (standard deviation) and SE (standard error), and the parametric statistical tests of significance were used. The independent samples t-test was used to test the statistical significance of difference in mean between 2 groups.

ANOVA test was used to test the statistical significance of difference in mean between more than 2 groups. Furthermore, when ANOVA model showed statistically significant differences, further exploration of the statistical significance of difference in mean between each 2 groups was assessed by LSD (Least Significant Difference).

ANOVA trend was used when the grouping variable was an ordinal level variable. The statistical significance of mean paired differences between right and left side measurements was assessed by paired t-test.

The CV% (coefficient of variation) measures the magnitude of variation in the measurements between the 2 sides. The variability (SD) of these errors are evaluated for magnitude by comparing its value to the mean or original readings

CV% = (SD of errors (paired differences) / mean of original measurement) x 100

RESULTS

The present study showed that there were non-significant statistical differences in PG measurements between the right and left sides in all dimensions and volume indicating that the enlargement was bilateral and symmetrical**.** In US the glands appeared homogenous with fatty infiltration that makes it hyperechoic in texture for patients with long duration of disease or poorer control DM. In Doppler there was no vascular changes that confirm its non-inflammatory condition.

Figure 1: USS-DVT4 Digital Rotary Viscometer

The effect of DM on physical properties of saliva

There was marked decrease in salivary flow rate and pH regardless the type of diabetes mellitus type I or II in comparison with normal, while the viscosity increased in study groups more than normal (table1).

The effect of DM on salivary Gland volume:

As shown in table 2, the mean salivary gland volume (SGV) was highest in type II DM (20.6ml) and lowest in healthy control (HC) (8.2ml). The difference in mean between 3 groups was significant statistically with (P<0.001). Having type II DM is expected to significantly increase the SGV by 3.9 ml compared to type I, which is significant statistically. This effect was strong (Cohen's d >2.4).

The association between the physical properties of saliva with the SG measurements in:

1-Type I DM:

1. Salivary flow rate: the correlation was very weak between the salivary flow rate and the SG measurements (table 3).

2. pH: the correlation was very weak between the salivary pH and the SG measurements(table 3).

3. Salivary viscosity: the viscosity was increased in diabetic patient, the viscosity of saliva had a very weak linear correlation statistically with the enlargement of the gland a as shown in table 3.

2-Type II DM:

1. Salivary flow rate: the correlation was very weak between the salivary flow rate and the SG measurements and it is statistically non-significant (Table 4).

2. pH: the correlation was very weak between the salivary pH and the SG measurements that are non-significant statistically (Table 4).

3. Salivary viscosity: the viscosity was increased in diabetic patient but this elevation in viscosity is not correlated with theenlargement of the gland statistically in a non-significant correlation (Table 4)

Table 1: The effect of DM on physical properties of saliva

Study group				
Variables	**Healthy controls N=34**	**Cases-Type-I DM N=34**	**Cases-Type-II DM N=34**	**P (ANOVA)**
Salivary flow rate (ml/min)				<0.001
Range	(0.3-0.5)	(0.05-0.3)	(0.05-0.3)	
Mean	0.4	0.14	0.17	
SD	0.05	0.07	0.07	
SE	0.008	0.012	0.012	
Salivary PH				<0.001
Range	(6.75-8.1)	(5.5-7.25)	(5.25-7)	
Mean	7.54	6.14	6.3	
SD	0.37	0.51	0.48	
SE	0.064	0.087	0.082	
Salivary viscosity				<0.001
Range	(0.95-1.63)	(1.2-3.5)	(1.07-2.6)	
Mean	1.24	1.93	1.73	
SD	0.18	0.52	0.45	
SE	0.031	0.089	0.077	

Table 2: The effect of Diabetes mellitus on salivary gland volume measurements

	Study group			P (ANOVA)
	Healthy controls	Cases-Type-I DM	Cases-Type-II DM	
Salivary gland volume (ml)- Mean of R and L side				<0.001
Range	(5 to 12.5)	(7 to 29.4)	(9.9 to 35.7)	
Mean	8.2	16.7	20.6	
SD	1.7	6.5	7.1	
SE	0.29	1.12	1.22	
N	34	34	34	
Range of normal values (5th-95th centile)	(5 to 11.4)			
Effect of DM compared to Healthy controls				
P (LSD)		<0.001	<0.001	
Difference in mean		8.5	12.4	
Cohen's d		1.79	2.4	
Effect of Type-II DM compared to Type-I DM				
P (LSD)			0.005	
Difference in mean			3.9	
Cohen's d			0.57	

DISCUSSION

Right and left difference in parotid gland US measurements

This study showed that there were no statistical significant differences in PG volume between the right and left sides indicating that the enlargement was bilateral and symmetrical, this is in agreement with many studies [16-21] where they reported that, sialadenosis in the PG is usually bilateral and symmetric but can be unilateral and/or asymmetric.

Effect of DM on salivary parameters and its correlation with sialadenosis

Lasisi and Fasanmade showed that diabetic patient had significant reduction in salivary flow rate when compared with non- diabetic individuals [22] which is compatible with the present article

Radhike and Ranganathan maintained that whole unstimulated and stimulated salivary flow rates were decreased in diabetic compared to non-diabetics and this difference was statistically significant (p=0.00)[23]. This finding was constant with other findings [24-28] which is in line with this study.

However, the results reported by Lasisi *etal.* Marder *et al.*, Dodds *et al.* and Collin *et al.*[22,29-31]showed no significant reduction in salivary flow rate in diabetes compared to non-diabetics, which is in contrast to the present study.

In a study by Moreira [32], salivary parameters of flow rate and pH were decreased, and it was concluded that the decrease in salivary pH is certainly due to decrease in unstimulated salivary flow.

In the present study, the US of the parotid glands appear homogenous with fatty infiltration that makes it hyperechoic in texture of patient with long duration of disease or poor control DM. In Doppler there were no vascular changes that confirm its non-inflammatory condition.

The normal PG appears homogenous and of increased echogenicity relative to the adjacent muscle on US. The increase echogenicity is related to the fatty glandular tissue composition of the gland [33-35]. In conclusion this study shows that there is positive correlation between the progressions of disease and salivary gland measurements, it also demonstrates that there is negative association between flow rate, pH, and viscosity of saliva in comparison with salivary gland measurements.

Table 3: The association between the physical properties of saliva with the SG measurements in Type I DM

Salivary flow rate (ml/min)-categories (DM)				
Type-I DM	**First (lowest) quartile (<=0.1)**	**Average (inter-quartile range) 0.11-0.19**	**Fourth (highest) quartile (0.2+)**	**P (ANOVA trend)**
Salivary gland volume (ml)-Mean of R and L side				0.63[NS]
Range	(7 to 29.4)	(9.7 to 27)	(9.6 to 28.9)	
Mean	16.5	19.4	15.3	
SD	7.1	6.9	5.3	
SE	1.77	2.62	1.6	
N	16	7	11	
r=-0.076 P=0.67[NS]				
Salivary PH-categories (DM)				
Type-I DM	**First (lowest) quartile (<=5.75)**	**Average (inter-quartile range) 5.8-6.49**	**Fourth (highest) quartile (6.5+)**	**P (ANOVA trend)**
Salivary gland volume (ml)-Mean of R and L side				0.53[NS]
Range	(7.2 to 28.8)	(12.8 to 29.4)	(7 to 27)	
Mean	14.2	19.2	16	
SD	6.5	6.1	6.4	
SE	1.95	1.64	2.12	
N	11	14	9	
r=0.013 P=0.94[NS]				
Salivary viscosity-categories (DM)				
Type-I DM	**First (lowest) quartile (<=1.48)**	**Average (inter-quartile range) 1.5-2.19**	**Fourth (highest) quartile (2.2+)**	**P (ANOVA trend)**
Salivary gland volume (ml)-Mean of R and L side				0.033
Range	(7 to 29.4)	(9.6 to 27)	(7.2 to 18.8)	
Mean	19.6	17.8	13.2	
SD	8.6	6.3	3.2	
SE	3.04	1.63	0.96	
N	8	15	11	
r=-0.329 P=0.06[NS]				

Table 4: The association between the physical properties of saliva with the SG measurements in Type II DM

Salivary flow rate (ml/min)-categories (DM)				
Type-II DM	**First (lowest) quartile (<=0.1)**	**Average (inter-quartile range) 0.11-0.19**	**Fourth (highest) quartile (0.2+)**	**P (ANOVA trend)**
Salivary gland volume (ml)-Mean of R and L side				0.82[NS]
Range	(11.3 to 23.8)	(11.4 to 35.7)	(9.9 to 32.5)	
Mean	19.3	22.7	20.1	
SD	4.1	9	7.4	
SE	1.35	2.83	1.91	
N	9	10	15	
r=-0.04 P=0.82[NS]				
Salivary PH-categories (DM)				
Type-II DM	**First (lowest) quartile (<=5.75)**	**Average (inter-quartile range) 5.8-6.49**	**Fourth (highest) quartile (6.5+)**	**P (ANOVA trend)**
Salivary gland volume (ml)-Mean of R and L side				0.87[NS]
Range	(9.9 to 31.7)	(10 to 28)	(11.3 to 35.7)	
Mean	20.8	19.2	21.3	
SD	6.8	6.5	7.8	
SE	2.58	2.17	1.84	
N	7	9	18	
r=-0.027 P=0.88[NS]				
Salivary viscosity-categories (DM)				
Type-II DM	**First (lowest) quartile (<=1.48)**	**Average (inter-quartile range) 1.5-2.19**	**Fourth (highest) quartile (2.2+)**	**P (ANOVA trend)**
Salivary gland volume (ml)-Mean of R and L side				0.76[NS]
Range	(12.6 to 32)	(9.9 to 35.7)	(11.3 to 31.7)	
Mean	19.6	21.3	20.6	
SD	6.4	8.2	6.3	
SE	2.02	2.06	2.24	
N	10	16	8	
r=-0.01 P=0.96[NS]				

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