CARIES, PERIODONTAL DISEASE AND TOOTH LOSS IN PATIENTS WITH DIABETES MELLITUS TYPES 1 AND 2

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ABSTRACT

The aim of this work was to determine the frequency of caries, periodontal disease and tooth loss in patients affected by diabetes mellitus types 1 and 2.

It was a cross-sectional study involving 175 subjects distributed in the following groups: 1) 35 patients with diabetes type 1 (glycosylated hemoglobin values from 6.5% - 7%), 2) 35 patients with diabetes type 1 (values of glycosylated hemoglobin higher than 7%), 3) 35 subjects without diabetes mellitus type 1, 4) 35 patients with diabetes type 2 and 5) 35 subjects without diabetes mellitus type 2. The following clinical parameters were evaluated for all the subjects who participated in the study: frequency of caries, filled teeth, missing teeth, prosthetic restoration, bacterial dental plaque, calculus index, probing depth and attachment level. On comparing the groups of patients with diabetes type 1 to the control group, there were no statistically significant differences among any of the study variables. On comparing the group of patients with diabetes type 2 to the control group, there were statistically significant differences in the variables missing teeth (p=0.0134), calculus (p=0.0001), probing depth (p=0.0009) and attachment level (p=0.0093). The variable periodontal disease showed statistically significant differences in the group of patients with diabetes type 2. Prevention, supervision and review of the oral health of patients with diabetes (types 1 and 2) are needed in order to prevent oral alterations.

Key words: Diabetes Mellitus type 1, Diabetes Mellitus type 2, dental caries, periodontitis, tooth loss.

CARIES, ENFERMEDAD PERIODONTAL Y DIENTES PERDIDOS EN PACIENTES CON DIABETES MELLITUS TIPO 1 Y 2

RESUMEN

La finalidad del presente trabajo fue determinar la frecuencia de la caries, enfermedad periodontal y dientes perdidos en pacientes diabéticos tipo 1 y 2. Se realizó un estudio transversal con un total de 175 sujetos, 105 pacientes diabéticos y 70 sujetos sin diabetes, distribuidos en los siguientes grupos: 1) 35 pacientes diabéticos tipo 1 (con valores de hemoglobina glucosilada de 6.5 a 7%), 2) 35 pacientes diabéticos tipo 1 (con valores de hemoglobina glucosilada mayores de 7%), 3) 35 sujetos sin diabetes mellitus tipo 1, 4) 35 pacientes diabéticos tipo 2 y 5) 35 sujetos sin diabetes mellitus tipo 2. Los sujetos se seleccionaron con un muestreo no probabilístico consecutivo. Los siguientes parámetros clínicos se evaluaron en todos los sujetos que participaron en el estudio: frecuencia de caries, dientes obturados, perdidos, restauraciones con prótesis (fija, removible y dentaduras completas), placa dentobacteriana, índice de cálculo, profundidad de bolsa y la pérdida de nivel de inserción epitelial. Al comparar los grupos de los pacientes diabéticos tipo 1 y el control no se encontramos diferencias estadísticamente significativas en todas las variables del estudio. Al comparar el grupo de pacientes diabéticos tipo 2 con el control se encontraron diferencias en las variables dientes perdidos (p=0.0134), cálculo (p=0.0001), profundidad de bolsa (p=0.0009) y pérdida de nivel de inserción epitelial (p=0.0093). La enfermedad periodontal mostró diferencias al comparar el grupo de pacientes diabéticos tipo 2 con el control. Es necesario la prevención, supervisión y revisión del estado de salud bucal de los pacientes diabéticos (tipo 1 y 2) para prevenir alteraciones bucales.

Palabras clave: diabetes, caries, periodontitis, dientes perdidos.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder that creates systemic complications and increases morbidity and mortality in affected subjects[1]. The prevalence of diabetes is about 14 million people in the United States, where it is the sixth leading cause of death[2]. In Mexico, according to the results of the 2000 National Health Survey, the prevalence of diabetes in subjects over 20 years of age was 7.5% (10% type 1 and 90% type 2)[3]. The usual complica-

tions that have been reported in diabetic patients are retinopathy, neuropathy, micro and macro-vascular alterations and oral complications[4-6]. The oral health of diabetic patients has been the subject of many studies in recent years. Caries, periodontal disease, xerostomy and tooth loss have been studied by different authors.

Dental caries is a multifactorial disease involving the presence of microorganisms, the host, the substrate and alteration of the immunological system. The frequency of dental caries in diabetic patients is a controversial issue[7]. On the one hand, it has been reported that there is no statistically significant difference between diabetic and non-diabetic patients regarding dental caries, saliva, dentobacterial plaque and diet[2,7], and low caries frequency has been found in diabetic patients due to their good oral hygiene, metabolic control and controlled diet[8]. However, other studies relate diabetic patients to high caries frequency[7] due to poorly controlled metabolism, poor oral hygiene, systemic complications (nephropathy), age, sex, presence of microorganisms and location of caries on the tooth. Some studies have evaluated the association between diabetes mellitus and the location of caries, studying the variables surface of root and coronal caries, gingival recession, periodontal condition, stimulation of salivary function, oral hygiene, presence of *streptococuss mutans, sanguinis, oralis, intermedius, lactobacillii, treponema denticola* and *prevotella nigrescens*. They report that diabetic patients showed a high prevalence of root caries and periodontitis, and also found factors associated to dental caries such as salivary buffer capacity and tooth loss[2,9-11]. Regarding periodontal disease, longitudinal and cross-sectional studies have reported that there is an association between diabetes mellitus (in children and adults) and the presence of cytokines, cardiovascular risk markers, age, sex, race, frequency of visits to the dentist, dentobacterial plaque, hemoglobin A1c, duration of diabetes, body mass index, gingivitis and periodontitis. They found statistically significant differences in the vascular risk markers E-selectin, VCAM-1 (vascular cell adhesion molecule-1) and PAI-1 (plasminogen activator inhibitor-1), in gingivitis, in periodontitis and between hemoglobin A1c and periodontitis[1,12,13]. There are also studies of immunologic system responses, exploring alterations in the oxidative function of leucocytes in patients with diabetes type 1 with periodontitis. The leucocytes were obtained from patients' peripheral venous blood flow, the method was based on chemoluminescence, and Russell's periodontal index was used to diagnose periodontal disease. They found low intensity with the chemoluminescence technique in diabetic patients with periodontitis compared to a control group ($p<0.001$)[14,15]. Experimental studies have described that with non-surgical periodontal therapy, in diabetic patients there is a significant reduction in total volume of GCF (gingival crevicular fluid), levels of interleukin-1β and tumor necrosis factor-α. In addition, diabetic patients showed improved metabolic control after 3 to 6 months' therapeutic intervention[16]. Some authors have reported tooth loss as an oral complication in diabetic patients, so prevention, detection and interaction are needed regarding oral pathology such as caries and periodontal disease in order to preserve patients' mastication, deglutition and phonation functions[17]. The controversy in literature and the small number of studies on the Mexican population, in which there is high prevalence of diabetes, are the main reasons for identifying frequency of caries, periodontal disease and missing teeth, with the aim of reporting the frequencies of these oral manifestations in patients with diabetes types 1 and 2, to produce data that will contribute towards the establishment of oral health prevention programs or systems in the future.

MATERIALS AND METHODS

A cross-sectional study was conducted from October 2004 to November 2007. The investigation protocol was approved by the Committee of Masters Postgraduate Degree in Dental Science of the Department of Comprehensive Advanced Dentistry. A total 175 subjects participated, including 105 diabetic patients and 70 subjects without diabetes, distributed into the following groups: 1) 35 patients with diabetes type 1 (with glycosylated hemoglobin values between 6.5% and 7%), 2) 35 patients with diabetes type 1 (with glycosylated hemoglobin values higher than 7%), 3) 35 subjects without diabetes mellitus type 1, 4) 35 patients with diabetes type 2, 5) 35 subjects without diabetes mellitus type 2. The subjects, selected by means of consecutive non-probabilistic sampling, met the following cri-

Table 1: Age, BMI, glucose, glycosylated hemoglobin, mean blood pressure, sex and hereditary family history in the study groups.

	Control n=35	Group DM1 HbA_1 (6.5 to 7%) n=35	Group DM1 HbA_1 (<7%) n=35	*p*
		Mean ± S.D.		
Age	16 ± 6.5	18 ± 7.6	19 ± 6.6	0.2668
BMI	21 ± 3.3	23 ± 5.2	21 ± 3.4	0.3714
Glucose	87 ± 7.9	111 ± 34.7	184 ± 51.3	0.0001
HbA_1 (%)	----------	6 ± 0.3	11 ± 2.3	---------
Mean blood pressure	91 ± 5.1	90 ± 4.6	90 ± 4.7	0.5420
		Frequency (%)		
Sex: Female	15 (43)	20 (57)	20 (57)	0.3850*
Hereditary history	32 (91)	28 (80)	27 (77)	0.2446*
	Control n=35	Group DM2 n=35		
		Mean ± S.D.		
Age	42 ± 9.0	45 ± 7.6		0.1102
BMI	29 ± 4.1	29 ± 4.1		0.0134
Glucose	89 ± 8.7	178 ± 43.1		0.0001
HbA_1	----------	8 ± 1.38		---------
Mean blood pressure	94 ± 6.5	92 ± 5.9		0.2473
		Frequency (%)		
Sex: Female	25 (71)	21 (60)		0.3138*
Hereditary history	14 (40)	27 (77)		0.0134*

Control: group of subjects without diabetes mellitus, Group DM1 HbA_1 (6.5 to 7%) = Diabetes mellitus type 1 with glycosylated hemoglobin values from 6.5% to 7%, Group DM1 HbA_1 (<7%) = Diabetes mellitus type 1 with glycosylated hemoglobin values greater than 7%, BMI = body mass index, Glucose = Blood glucose (mg/dl), HbA_1= glycosylated hemoglobin (%), Hereditary history= Hereditary family history, DM2=Diabetes Mellitus type 2, Comparison of glycosylated hemoglobin: Group DM1 HbA_1 (6.5 a 7%) vs. Group DM1 HbA_1 (<7%) (p=0.0001), S.D. = Standard Deviation, Kruskal Wallis, *Chi Square.

teria: Inclusion - **Group 1**: patients with diabetes type 1 with glycosylated hemoglobin values between 6.5% and 7% and blood glucose levels under 110 mg/dl., of either sex, aged 8 to 30 years, with 5 or more years evolution of diabetes as from diagnosis, and without arterial hypertension. **Group 2:** patients with diabetes type 1 with glycosylated hemoglobin values higher than 7% and blood glucose levels higher than 110 mg/dl., of either sex, aged 8 to 30 years, with 5 or more years evolution of diabetes as from diagnosis, and without arterial hypertension. **Group 3 (control):** subjects without diabetes type 1, of either sex, aged 8 to 30 years, with glucose values < 110 mg/dl, with body mass index (height and weight) < 27 Kg/m^2 and without arterial hypertension. **Group 4:** patients with diabetes type 2, of either sex, aged 30 to 60 years, with 5 or more year's evolution of diabetes as from diagnosis and without arterial hypertension. **Group 5 (control):** subjects without diabetes type 2, of either sex, aged 30 to 60 years, with glucose values < 110 mg/dl, with a body mass index < 27 Kg/m^2 and without arterial hypertension. Exclusion criteria for all groups were pregnancy, patients with evident genetic pathologies, treatment of periodontal disease, treatment for epilepsy or kidney transplant. Written informed consent and a general clinical and dental history were obtained for each patient.

A blind (regarding the diabetes diagnosis) evaluation was made of the following clinical parameters on all teeth of the participating subjects, except third molars: 1) Frequency of caries, filled teeth, missing teeth and prosthetic restoration (fixed, removable and full denture). Fixed and removable dentures were evaluated as number of replacement teeth. 2) DMFT index –the sum of decayed, missing and filled teeth. 3) Oral hygiene - Plaque Index – the presence of dentobacterial

Table 2: Decayed, filled, missing teeth, prosthesis, DMFT index, oral hygiene and periodontal disease in study groups.

Variables	Control n=35	Group DM1 HbA_1 (6.5 a 7%) n=35	Group DM1 HbA_1 (<7%) n=35	*p*
		Mean ± S.D.		
Caries	3.8 ± 3.4	5.5 ± 4.8	4.1 ± 4.0	0.5150
Filled	0.2 ± 0.7	1.9 ± 4.6	2.5 ± 3.8	0.9953
Missing	2.2 ± 3.2	1.3 ± 2.2	2.0 ± 3.2	0.9509
Prosthesis	0.0 ± 0.0	0.0 ± 0.0	0.7 ± 2.8	0.9999
DMFT	6.3 ± 4.0	8.8 ± 4.8	8.6 ± 5.9	0.4985
Plaque	3.9 ± 0.8	3.7 ± 0.9	4.0 ± 1.0	0.4841
Calculus	0.2 ± 0.4	0.6 ± 0.9	0.9 ± 1.3	0.7057
PPD	2.5 ± 0.2	2.5 ± 0.3	2.8 ± 1.1	0.5184
EAL	1.8 ± 0.3	1.8 ± 0.3	2.1 ± 0.6	0.9999
	Control n=35	Group DM2 n=35		
Caries	10.9 ± 6.1	10.5 ± 6.0		0.6176*
Filled	3.7 ± 3.7	3.4 ± 3.7		0.5769*
Missing	3.5 ± 2.9	5.7 ± 3.7		0.0134*
Prosthesis	1.4 ± 2.3	1.9 ± 3.2		0.4701*
DMFT	18.2 ± 3.5	19.6 ± 3.9		0.0742*
Plaque	3.4 ± 1.7	3.5 ± 1.7		0.6596*
Calculus	0.9 ± 0.9	2.1 ± 0.7		0.0001*
PPD	2.6 ± 0.6	4.4 ± 1.7		0.0009*
EAL	2.6 ± 0.6	2.8 ± 0.7		0.0093*

Control: group of subjects without diabetes mellitus, Group DM1 HbA_1 (6.5 a 7%) = Diabetes mellitus type 1 with glycosylated hemoglobin values from 6.5% to 7%, Group DM1 HbA_1 (<7%) = Diabetes mellitus type 1 with glycosylated hemoglobin values greater than 7%, DM2=Diabetes mellitus type 2, DMFT = number of decayed, missing and filled teeth, PPD = Pocket probing depth, EAL = epithelial attachment loss. S.D. = Standard deviation, Kruskal-Wallis, *U. Mann Whitney.

plaque on all tooth surfaces was recorded (Silness and Löe, 1964); Calculus Index – the presence of supra and subgingival calculus was evaluated on 4 tooth surfaces (mesial, distal, buccal and lingual), and the average calculated (Greene and Vermillion 1964). 4) Periodontal Evaluation – probing depth and loss of epithelial attachment were recorded with a calibrated periodontal probe graduated in mm (Hu-Friedy). Probing depth was measured from the gingival margin to the base of the pocket, considering a healthy sulcus as < 3 mm. The level of epithelial attachment was evaluated from the cemento-enamel junction to the base of the sulcus, considering a healthy sulcus as < 2 mm. The examiner underwent standardization for all variables during a pilot study on a total 60 subjects. Intra- and inter-observer data reproducibility was evaluated with Kappa and the intraclass correlation coefficient. All data were expressed as mean ± standard deviation, frequencies and percentage. To determine the distribution of the variables, the Shapiro-Wilk and Brown-Forsyte statistical tests were used. The statistical tests used for analyzing the data were U. Mann Whitney and Kruskal Wallis to compare quantitative variables, Chi Square for qualitative variables, and Spearman statistical test for correlations among variables. Logistic regression was used to calculate the odds ratio (with a 95% confidence interval) in the group of patients with diabetes type 2. In the analysis, the dependent variable was presence or absence of loss of attachment level and the independent variables were missing teeth, periodontal pocket probing depth and diabetes. The results were analyzed using the JMP V. 4 statistical software (SAS Institute) with an imposed alpha level of $p<0.05$.

RESULTS

Inter- and intraobserver standardization for all variables had concordance greater than 0.80. Table 1 shows age, body mass index, glucose, glycosylated hemoglobin, mean blood pressure, sex and hereditary family history for all the study groups. Comparison of the group of patients with diabetes type 1 to the control group showed statistically significant differences in the variables blood glucose and glycosylated hemoglobin *(p=0.0001)*. Comparison of the group of patients with diabetes type 2 to the control group showed statistically significant differences in body mass index *(p=0.0134),* blood glucose *(p=0.0001)* and hereditary family history *(p=0.0134)*. Table 2 compares groups regarding presence of caries, filled

Table 3: Frequency of subjects with decayed, filled, missing teeth, prosthesis, DMFT index, probing depth and loss of epithelial attachment level in the 5 study groups.

Variables	Control n=35	Group DM1 HbA_1 (6.5 a 7%) n=35	Group DM1 HbA_1 (<7%) n=35	Control Vs Group DM1 HbA_1 (6.5 a 7%)	Control Vs Group DM1 HbA_1 (<7%)	Group DM1 HbA_1 (6.5 a 7%) Vs Group DM1 HbA_1 (<7%)
			Frequency (%)	*p*	*p*	*p*
Decayed	29 (41)	29 (41)	30 (43)	0.9999	0.7426	0.7425
Filled	5 (7)	12 (17)	16 (23)	0.0510	0.0041	0.3291
Missing	16 (23)	13 (18)	13 (18)	0.4667	0.4667	0.9999
Prosthesis	0 (0)	0 (0)	4 (8)	---------	0.1142	0.1142
DMFT	31 (44)	33 (47)	31 (44)	0.3932	0.9999	0.3932
PPD <3mm	2 (3)	2 (3)	5 (7)	0.9999	0.2320	0.2352
EAL <2 mm	0 (0)	0 (0)	3 (4)	---------	0.2391	0.2391
		Control n=35		Group DM2 n=35		Control Vs Group DM2 *p*
Decayed		35 (50)		33 (47)		0.1513
Filled		27 (38)		22 (31)		0.1906
Missing		29 (41)		35 (50)		0.0104
Prosthesis		13 (18)		17 (24)		0.3334
DMFT		35 (50)		35 (50)		0.9999
PPD <3mm		12 (17)		21 (30)		0.0302
EAL < 2mm		24 (34)		26 (37)		0.5965

Control: group of subjects without diabetes mellitus, Group DM1 HbA_1 (6.5 to 7%) = Diabetes mellitus type 1 with glycosylated hemoglobin values from 6.5% to 7%, Group DM1 HbA_1 (<7%) = Diabetes mellitus type 1 with glycosylated hemoglobin values greater than 7%, BMI = body mass index, Glucose = Blood glucose (mg/dl), HbA_1= glycosylated hemoglobin (%), Hereditary history= Hereditary family history, DM2=Diabetes Mellitus type 2, Comparison of glycosylated hemoglobin: Group DM1 HbA_1 (6.5 a 7%) vs. Group DM1 HbA_1 (<7%) (p=0.0001), S.D. = Standard Deviation, Kruskal Wallis, *Chi Square.

teeth, missing teeth, prosthesis, DMFT index, oral hygiene and periodontal disease. Comparison of the group of patients with diabetes type 1 to the control group showed no statistically significant differences in the study variables. Regarding the group of patients with diabetes type 2, no statistically significant differences were found for the variables decayed teeth, filled teeth, prosthesis, DMFT index and bacterial plaque when it was compared to the control group, but there were differences for the variables missing teeth (*p=0.0134*), calculus (*p=0.0001*), probing depth (*p=0.0009*) and loss of epithelial attachment level (*p=0.0093*). The results of the correlations in patients with diabetes type 2 were: for probing depth and missing teeth (r=0.039, *p=0.7457*) and for loss of epithelial attachment level with missing teeth (r=0.116, *p=0.3368)*. Regarding the logistic regression analysis, the dependent variable in patients with diabetes type 2 was loss of attachment level and the independent variables were missing teeth, periodontal probing depth and diabetes. We found statistically significant differences (*p*=0.0068) with OR= 1.4 in probing depth. In the variables diabetes and missing teeth (*p*>0.05) we found no difference with OR= 2.3 in diabetes and OR=0.1 in missing teeth. Table 3 shows the frequency of subjects with decayed, filled or missing teeth, prosthesis, DMFT index, probing depth and loss of epithelial attachment level in the 5 study groups. Caries and DMFT index were the variables with greatest frequency in all study groups, from 29 (41%) to 35 (50%). Statistically significant differences were found on comparing the group of patients with diabetes type 2 to the control group regarding missing teeth (p=0.0104) and probing depth (p=0.0302).

DISCUSSION

Several researchers have evaluated the oral manifestations in patients with diabetes types 1 and 2. In this study we evaluated the frequency of decayed teeth, filled teeth, prosthesis, DMFT index, bacterial plaque, calculus, probing depth, level of epithelial attachment and missing teeth in patients with diabetes types 1 and 2.

No statistically significant difference was found in dental caries on comparing patients with diabetes type 1 to the control group ($p<0.05$), nor on comparing patients with diabetes type 2 to the control group ($p=0.1513$). The presence of dental caries in diabetic patients is a matter of controversy[5]. The mechanisms proposed by various researchers who report an association between the reduction of caries and diabetes mellitus are: metabolic control of diabetes, diet with low carbohydrate content, increase in proteins, increase in saliva buffer capacity and delayed eruption of permanent teeth, reducing tooth exposure time in the mouth[2,5,7,8,18].

Conversely, an association between diabetes and the increase in caries has been reported, explained by lack of metabolic control, increase in salivary glucose, crevicular fluid and decrease in saliva flow[5,18]. Although our results did not show statistically significant differences between groups, the percentage of frequency of subjects with caries was 41% to 50%. The highest frequency was found for molars and upper maxillary teeth. Some authors have reported that eating habits, presence of bacteria, saliva, sociodemographic level and other predictors such as tooth composition, position, function and morphology are risk factors for the development of dental caries[19].
Another field of work for multidisciplinary teams is the association between diabetes and periodontal disease[20,21,22,23]. There is controversy regarding the association between periodontal disease and patients with diabetes type 1 as well as periodontal disease and poor metabolic control. Our study found no statistically significant difference in the variables probing depth (p= 0.7398) and level of epithelial attachment (p=0.5537) on comparing the groups of patients with diabetes type 1 to the control group, in agreement with other researchers[24,25]. On the other hand, an association between diabetes mellitus type 1 and periodontal disease has been reported, as well as an association with poor metabolic control and periodontal disease[2,5,8,6]. We believe that controversy on these subjects is due to different factors such as methodology, selection criteria and strategies used for analyzing the results.

With regard to diabetes mellitus type 2 and periodontal disease, it has been documented bidirectionally, i.e. diabetes type 2 is associated with the increase in frequency and progression of periodontitis, and periodontal infections are associated to poor glucose control in patients with diabetes type 2 [6,26]. Our study found statistically significant differences in calculus ($p=0.0001$), probing depth (0.0009) and loss of level of epithelial attachment ($p=0.0093$) on comparing the group of patients with diabetes type 2 to the control group, in agreement with other studies[27,28]. The main factors that have been reported and which contribute to the development of periodontal disease in diabetic patients are: 1) non-enzymatic process to form advanced glycation end products (AGEs) causing augmented IL-1 and TNF-α secretion**,** 2) infections in diabetic patients due to immunological alterations, 3) presence of gram-negative anaerobic bacteria (*Actinobacilus actinomycetemcomitans, Porphyromonas gingivalis,* etc.), 4) alterations of the microcirculatory blood flow in periodontal tissues and 5) other associated factors such as age, how long a patient has had diabetes since it was diagnosed and metabolic control[8,20,22,23,26,29,30,31]. With regard to tooth loss, our study found no difference on comparing the groups of patients with diabetes type 1 to the control group ($p>0.05$). However, on comparing patients with diabetes type 2 to the control group, we found differences ($p=0.0123$), in agreement with some published reports[11,32,33]. The association between missing teeth and diabetes is not very clear, but it is important to identify the possible role of other factors such as orthodontic treatments, traumas, prosthesis, third molars, and social, cultural and economic factors[5,33,34] in order to identify the association.

It is necessary and helpful to design individualized prevention strategies according to the needs of each patient, including visits to the dentist, oral education programs, clinical evaluation (medical and oral history) and eating habits, in order to achieve and maintain oral health in diabetic patients.

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