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DOI: 10.23804/ejpd.2018.19.02.05

Dental, periodontal and salivary conditions in diabetic children associated with metabolic control variables and nutritional plan adherence

ABSTRACT

Background *Diabetes mellitus is a chronic disease that has manifestations other than alterations in endocrine regulation or in metabolic pathways. Several diseases of the oral cavity have been associated with diabetes mellitus type 1 and 2 in young people according to their evolution. Scarce information exists regarding the role of diabetes and its association with the oral health status in paediatric diabetic patients. The aims of the study were to assess the quality of saliva, saliva acidogenicity, dental caries experience, fluorosis and periodontal status in diabetic patients and to evaluate their relationship with metabolic control variables and nutritional plan adherence.*

Material and methods *The study population consisted of 60 paediatric patients with both types of diabetes mellitus. Saliva testing included stimulated flow, pH (using pH indicator strips), buffer capacity and Snyder's Test. DMFT/dmft and dental caries experience were determined on the basis of ICDAS II codes. The periodontal status was assessed by PI and GI and fluorosis by FI. Nutritional plan adherence was established from the subscale "Dietary Control" of the Diabetes Self-Management Profile questionnaire. Medical Data was retrieved from the clinical registers in the Diabetic Clinic.*

Results *We describe the main characteristics of the oral cavity related variables of our population that might guide the clinical practice in similar settings; we found a dmft/DMFT of 1.71 ± 1.74 and 0.64 ± 1.03, PI of 1.91 ± 0.75, GI of 0.50 ± 0.56 and a fluorosis prevalence of 61%. We identified several correlated variables, which indicate strong associations between the nutritional habits of the patients and co-occurrence of oral cavity physiopathological alterations. Several correlations were found between acidogenic activity of the saliva (Snyder Test) and the percentage of adherence to the nutritional plan and to the dmft index. Furthermore, a significant correlation between the buffering capacity of the saliva and the glycemic control of the participants was found. Neither an association nor a difference among means was found between treatment regime and the plaque index.*

Conclusion *The results of the present study concluded that there was a significant relationship between diabetes mellitus and an increased prevalence of oral cavity related diseases in the paediatric population. These are also associated with a poor adherence to the nutritional plan.*

Keywords *Diabetes mellitus, Diabetes mellitus children, Oral health.*

Introduction

Diabetes Mellitus (DM) represents an important public health problem in Mexico due to the high costs, chronicity and increasing prevalence in adults, with a strong unexpected impact in the young population.

North America (USA, México and Canada) and the Caribbean are the regions with the highest prevalence (12.9%) in adults, compared to other regions [FID, 2013]. Among the paediatric population, type 2 diabetes (DM2) has increased in recent years, although type 1 diabetes (DM1) remains the most common form.

The DIAMOND project, based on data from 57 countries around the world, estimated that the annual incidence of type 1 diabetes in children under 15 years old ranged from 0.1 per 100,000 in China, to 40.9 per 100,000 in Finland [Karvonen, 2006].

The differences observed in the distribution of DM1 incidence are due to different factors such as genetic, geographical location, ethnicity, among others [Karvonen, 2006, Harron et al., 2011]. Some patients cannot be clearly classified as type 1 or type 2 because the clinical presentation is highly variable, but the diagnosis becomes clearer over time [Elangovan et al., 2014].

The HbA1c determination is the standard for long-term glycemic control in patients with diabetes. It has been shown that maintaining this figure below 7% (53 mmol/mol) reduces microvascular and macrovascular complications associated with diabetes; therefore, it has been established as the treatment target [American Diabetes Association, 2017]. Previously, blood glucose targets were set for each age group according to recommendations from ADA 2014 [Iglesias González et al., 2014], currently determined for the general paediatric population as 7% [American Diabetes Association, 2017], or 7.5% according to ISPAD 2014 [Beaufort et al., 2014].

Despite the development of new therapeutic strategies, the creation of insulin analogues, insulinisation technologies and monitoring systems, a majority of patients continue to fail to achieve and/or stay within their HbA1c targets. In 2014, Pinhas and colleagues, after monitoring patients over a 15-year period, showed that variability in HbA1c values is a factor that cannot be suppressed in their passage from childhood to adulthood once diagnosed with DM [Pinhas et al. 2014]. As with other complications associated with diabetes, oral complications are related to the subject's ability to control blood glucose levels and overall health. The most commonly reported oral health complications for type 1 are xerostomia, periodontal disease, abscess, tooth loss, soft tissue injury, and dry mouth syndrome. Type 2 diabetics suffer from complications such as periodontal disease, oral candidiasis, tooth loss [Blanco Arrieta et al., 2003], oral mucosal ulcers, taste disorders, xerostomia and salivary hypofunction [Bajaj et al., 2012].

Depending on the type of diabetes, patients with type 1 show a significantly lower salivary flow rate, unlike those with type 2 in which a slight reduction (20%) has been observed, in comparison to healthy individuals [Malicka et al., 2014].

Furthermore, some studies in male diabetic Wistar rats have shown that DM1 condition causes a suppression of enamel and dentin formation, although it does not affect the density of either structure. This indicates that diabetic patients may be more susceptible to tooth decay and discrepancies in tooth size [Abbassy et al., 2015].

As far as periodontitis is concerned, this is a major infection with systemic repercussions because it can affect different organs and tissues by releasing bacteria, their products and mediators of inflammation into the bloodstream. More recently, the role of diabetes as a risk factor for periodontal disease has been investigated, and a number of such studies suggest a bilateral relationship, in the sense that the infection may weaken the metabolic control of the disease by inducing some degree of insulin resistance [Plančak and Puhar, 2012; Löe, 1993; Lalla et al., 2006]. The relationship between periodontal disease and diabetes is not unidirectional; therefore, periodontitis has a negative effect on glycemic control and increases the risk for other systemic complications [Plančak and Puhar, 2012].

In addition, there are reports that in groups of type 1 diabetics, as HbA1c concentration increases, salivary flow is reduced, bleeding of the gums is increased, and more decayed teeth are observed in the permanent dentition, as well as an increase in the CPI (Community Periodontal Index) [Carneiro et al., 2015].

As a result, an oral assessment should be part of routine procedures in the care of children and adolescents with DM1 in addition to investigating the symptoms associated with hyposalivation, such as dysgeusia, among others. Therefore, the integration of a dentist in the multidisciplinary medical team is a priority. This study was conducted with the aim of evaluating the association of glycemic control with the oral health in a group of children and adolescents with diabetes.

Materials and methods

This was a descriptive and correlational study developed in the Childhood Diabetes Clinic of the Zacatecas General Hospital "Luz González Cosío". It was approved by the Research Ethics Committee (HGZ/051/2015 dated 25-Oct-2015) and by the ACS/UAZ Bioethics Committee and was carried out in accordance with the standards set forth in the Declaration of Helsinki and the Mexican Regulations of the General Law on Health in the Field of Research for Health (2014), the NOM-012-SSA3-2012 and the NOM-013-SSA2-2006. Written informed assent and/or consent were obtained from the patients and/or their parents, respectively.

Patients

According to the inclusion criteria, patients diagnosed with diabetes mellitus younger than 18 years of age, with 12 months completed since diagnosis and who had a complete medical record with HbA1c values from the previous 6 months were recruited. Those who were under orthodontic/orthopaedic procedures, who had received periodontal treatment in the previous 6 months and/or did not have the required information in their medical records were excluded. Patients with both type 1 and type 2 diabetes were included.

Oral evaluation

A single researcher conducted the oral health evaluation. The intra-examiner reliability was considered acceptable, with a kappa value of 0.78 for dental caries index. The oral examination was conducted in artificial light with a dental mirror (no. 5, Dental USA) and a periodontal probe WHO (Hu Friedy). The mouth was divided into sextants and six index teeth were utilised to evaluate oral hygiene and periodontal health. Oral hygiene was assessed with the Simplified Oral Hygiene Index (SOHI) for detritus as described by Greene-Vermillion (1960) and was coded as good (0.0-0.6) regular (0.7-1.8) and bad (1.9-3.0) hygiene based on the average obtained from the evaluated teeth. Gingival status was determined using Plaque Index (PI) and Gingival Index (GI), according to Silness & Löe (1964 and 1963, respectively). For PI, an acceptable degree of hygiene was considered when the average of the evaluated teeth was 1 or less. For GI, patients were classified in the categories of mild, moderate and severe gingivitis based on the average obtained.

Caries prevalence, dmft (decayed, missing and filled in primary teeth) and DMFT (in permanent Teeth) were set from the Caries Detection and Assessment System II (ICDAS II) registers. The relative accumulated caries experience was determined according to Grainger and Nikiforuk (1960).

As an endemic area of fluorosis and in order to dismiss its influence on dental caries experience, the degree of alteration in temporal (upper and lower second molars) and permanent (anterior region of canine to canine) dentition was established according to Dean's criteria (1942).

Data regarding the type and duration of diabetes, therapeutic regimen, HbA1c, weight, height and BMI was obtained from medical records and data of dental interest like the age of tooth brushing onset, age of first consultation and frequency of brushing was collected in the interview.

Evaluation of the physicochemical properties of saliva

Samples of stimulated saliva from the participants were collected after chewing a piece of parafilm and then spitting out the produced saliva inside a container, repeatedly over 5 minutes. To determine salivary flow, the volume of saliva was divided by the time taken for collection and expressed in ml/min. A flow >0.7 ml/min was considered Normal, 0.3 - 0.7 ml/min reduced, and < 0.3 ml/min very reduced [Kats et al., 1983].

The pH was assessed with a pH indicator strip (CIVEQ ®). To evaluate the buffer capacity, 1 ml of the sample and 1 ml of 0.005 M hydrochloric acid were placed in a glass tube, mixed and rested for a couple of minutes. A pH equal to or less than 4 was considered as a poor damping condition.

The Snyder test was used to determine the rate of acid production by acidogenic oral microorganisms, which is correlated with the consumption of fermentable sugars and the activity of dental caries. An aliquot of 0.1 ml of collected saliva was added to 4.5 ml of melted Snyder's medium at body temperature (36.5 ° C) in a test tube, mixed by inversion, incubated at 37 °C and checked at 24, 48 and 72 hours for color change from blue-ish to yellow. The test was considered positive when a color change was observed and the incubation was stopped. According to the time when the color change occurred, a high, moderate and low activity was considered (24, 48, 72 or more hours).

Determination of adherence to the nutritional plan

To assess self-care and determine the adherence to the nutritional plan, a questionnaire with 9 items of the 'Dietary Control' (DC) subscale, in the Diabetes Self-Management Profile (DSMP) was applied to patients and their parents. The percentage of adherence was calculated from the obtained score. The instrument was applied to participants aged 11 or over and their parents separately, to assess the participants' self-care for 3 months in relation to the adherence to the Nutrition Plan. For children under 11 years old, it was applied to parents and children together [Harris et al., 2000].

Statistical analysis of data

The data was analysed using the Statistical Package for the Social Sciences® software (version 21.0; SPSS Inc., Chicago, IL, USA). To be able to compare the value of oral health related variables within groups with different HbA1c values, their normality was evaluated by the Kolmogorov-Smirnov test. The calculation of frequency distribution, mean and standard deviation was carried out. Comparison of means was carried out with T tests and non-parametric Mann Whitney U test according to data distribution. Correlation among variables was determined with the Pearson and/or Spearman tests. The adopted significance level was 5% (alpha= 0.05).

Results

General features of the study population

From December 2014 to March 2015, 76 patients attended the clinic (38 females and 38 males), 14 were excluded from the study because they did not meet the time since diagnosis criteria, one was under orthopaedic treatment, and another did not comply the HbA1c values for the previous 6 months. The final sample consisted of 60 children and adolescents (30 girls and 30 boys) in a range of 2 to 16 years old, and a mean age of 11 years (± 3.29 years). The mean age at the time of examination for DM1 patients was 10.85 (±3.35), and 13.00 (±0.81) for DM2.

The mean time since diagnosis was 50.90 (± 37.42) months. The four DM2 cases (6.7%) were female and had an average of 22.5 months since diagnosis, whereas the DM1 children had 52.93 months of evolution.

Regarding the therapeutic regimen prescribed, 49 used a conventional regimen (81.7%) with NPH insulin alone or in combination with Lispro, fast or metformin.

		n (%)	Mean	SD
Age (years)	All	60 (100)	11	3.29
	Girls	30 (50)	11.4	3.31
	Boys	30 (50)	10.6	3.27
DM (type)	Type 1	56 (93.3)		
	Type 2	4 (6.7) *		
Months since diagnosis	All	60 (100)	50.9	37.42
	Type 1	52.93 (56)		
	Type 2	22.50 (4)		
Therapeutic regimen	Conventional	49 (81.7)		
	Intensified	11 (18.3)		
HbA1c	All	60 (100)	9.01	2.21
HbA1c Goal	Controlled	17 (28.3)	6.59	0.97
	Uncontrolled	43 (71.7)	9.97	1.79
SOHI	All	60 (100)	1.77	0.53
SOHI categories	Good	1 (1.7)		
	Regular	37 (61.7)		
	Deficient	22 (36.7)		
dmft		32 (53.3)	1.71	1.74
DMFT		54 (90)	0.64	1.03
PI	All	51 (85)		
	Acceptable	6 (10)	1.91	0.75
	Not acceptable	45 (75)		
		51(85)		
GI	Light	30 (50)		
	Moderate	5 (8.3)	0.50	0.56
	Severe	1 (1.7)		
Caries experience (CExp) ≈	High	4 (6.7)		
	Low	31 (51.7)		
	Resistant	25 (41.7)		
Salivary flow (ml/min)		50 (85)	1.43	1.09
	Type 1	47 (70)	1.34	0.61
	Type 2	3 (5)	1.22	0.91
Salivary flow categories	Normal	44 (73.3)		
	Reduced	6 (10)		
Salivary Alcalinity		50 (85)	6.76	0.65
Buffer capacity (pH)		50 (85)	5.43	1.11
	Type 1	47 (70)	5.57	0.82
	Type 2	3 (5)	5.0	
Buffer capacity categories	Good			
	Regular	27(45)		
	Bad	18 (30)		
Caries Activity (Snyder Test)	All	5 (8.3)		
	High	50 (85)		
	Type 1	43 (71.7)		
	Type 2	40 (66.6)		
	Moderate	3 (5)		
	Type 1	5 (8.3)		
	Type 2	5 (8.3)		
	Null	0 (0)		
	Type 1	2 (3.3)		
	Type 2	2 (3.3)		

*The four DM2 cases observed were female. Definition of control based on the ADA recommendation of 2016. CExp. Cumulative relative caries experience according to Grainger and Nikiforuk (1960)

TABLE 1 Descriptive statistics and frequencies of observed variables.

The rest was under an intensified scheme (18.3%) with insulin Glargine in combination with Lispro and / or fast (Table 1).

Of the participants 28.3% and 71.7% were placed in the control or uncontrol categories if the last measurement of HbA1c was less or greater than 7%, respectively (ADA, 2016).

The history of oral care showed that the average age at which they attended their first dental consultation was at 7.73 years (± 2.97). 68.3% (41) mentioned having had previous dental visits, and the rest (31.7%) had never attended or did not remember having done so.

During the interview, 51 patients (85%) were able to provide the age of dental brushing onset, and the rest (15%) said they did not remember or that they did not yet begin it. For those who had already started this habit, the mean age of onset was at 4.21 years (± 2.52).

Regarding the frequency of toothbrushing, 26.7% did not perform any brushing a day, 35% performed it only once a day, 36.7% brushed twice a day and finally one patient (1.7%) mentioned that he performed it four times a day.

Despite the frequency of brushing reported, we found high scores of detritus by SOHI and in PI (the general characteristics of the patients associated to caries prevalence and other oral cavity variables are further described in Table 1). The overall prevalence of caries in the study group was 58.3%, in a low degree of affectation in dmft, DMFT and CExp. We found incipient affectation in soft tissues according to GI scores.

Prevalence of fluorosis was 66.6%, in the very mild, mild, moderate and severe (8.3, 11.6, 23.3 and 18.3%, respectively) codes.

During this period, it was possible to collect the saliva of 50 participants, the rest were not present on the day of collection or were very young and collection was not possible. The mean saliva production for the entire study population was 1.43 ml/min (± 1.09). The mean salivary acidity was 6.76 (± 0.65) and the mean pH buffering capacity was 5.43 (± 1.11).

The Snyder test was applied to determine the acidogenic activity of saliva, 71.7% (43 patients) showed a high activity, 8.3% moderate (5 patients) and only 3.3% a null activity.

Analysis of DSMP subscale dietary control according to type of diabetes or therapeutic scheme

In order to determine differences in adherence to the nutritional plan when comparing the groups stratified by type of diabetes or therapeutic scheme, the subscale Dietary control of the DSMP was applied. It was possible to evaluate the percentage of adherence in 48 patients, 20 of them aged 11 years or more, and 28 younger children and their parents. DM1 children showed an average of 70.10% (± 13.61%) of adherence, and DM2 60.91% (± 17.27), no statistically significant differences were observed between the means according to the type of diabetes (p = 0.26), or to the therapeutic scheme (p = 0.32).

According to the category CExp, a lower percentage of adherence (62.66%) was observed in those who were in the Resistant category, meanwhile it was 74.78 and 72.40% in the Low and High groups, respectively.

Relationship of anthropometric variables to metabolic control, oral health and adherence to nutritional plan

Given that oral health might be intertwined with the physical characteristics of the subjects and that several indexes have been used to predict the development of both diabetes and metabolic disease, we evaluated the correlation between anthropometric data and type of diabetes, glycemic control (HbA1c%), etc.

A significant correlation was observed between the anthropometric variables (height, weight and BMI) and type of diabetes. Likewise, a positive correlation was observed between the prescribed therapeutic regimen (habitual or intensified) and the body mass index, and between the type of diabetes and the category of control or glycemic control. A negative correlation was determined between the percentage of adherence and the age of the participants, BMI and gender, weight and percentage of adherence, as well as between the therapeutic scheme and gender, as shown in Table 2.

Variable	Type of DM	BMI	Therapeutic regimen (Usual/ Intensified)	Adherence (%)
Age (years)				- .467 ** 0.001
Size (cm)	.235 * 0.028			
Weight (kg)	.348 ** 0.001			- .385 ** 0.007
Body Mass Index (BMI)	.394 ** 0.001		.220 * 0.040	
Glycemic control (Control/ Uncontrol)	.277 * 0.032			
* The correlation is significant at the 0.05 level (bilateral) ** The correlation is significant at the 0.01 level (bilateral)				

TABLE 2 Correlation between variables of the general evaluation.

We found an association of BMI with the female gender (p 0.020), and between the usual therapeutic regimens with female gender (p 0.021) too.

Regarding the variables of dental interest, significant differences were obtained between the gender of the participants and the SOHI (T test, p 0.049) and between gender and caries dmft score (0.012) and CExp (0.034).

Fluorosis has been associated with a reduced risk of caries; therefore, we analyzed whether the high

Variable	SOHI	dmft	DMFT	First dental visit (age)	pH	Buffer capacity	Acidogenic Activity (Snyder)
Gender (f/m)	.259* 0.046	.364* 0.023					
Age (years)			.307* 0.024	.582** 0.000			-.313* 0.029
Weight (kg)				.524** 0.000			
Adherence to nutritional plan (%)		-.507** 0.008					0.347* 0.020
Control/Uncontrol (HbA1c)						0.319* 0.024	
Glycemia (HbA1C)		-.436* 0.013					
Therapeutic regimen (Usual/Intensified)				.477** 0.000			
Onset of brushing				.385* 0.007			
Frecuency of brushing		- .383* 0.030					
Salivary flow (ml/min)					0.413** 0.003	-.308* 0.029	
* The correlation is significant at the 0.05 level (bilateral) ** The correlation is significant at the 0.01 level (bilateral)							

TABLE 3 Correlation between variables of buccal interest and saliva quality.

prevalence of dental fluorosis was related to a trend in the reduction of caries experience (CExp) in our population. No trend was identified among these individuals (p=0.177) suggesting that other factors are associated with caries risk in these patients.

There was a positive correlation between acidogenic activity of the saliva (Snyder Test) and the percentage of adherence to the nutritional plan (p 0.020, rho 0.347), and also between the buffering capacity of the saliva and the categories of control or uncontrol (p 0.013, rho 0.332). In the evaluation of salivary flow, a positive correlation of salivary flow with pH was obtained (p 0.003, rho 0.413) (Table 3).

We found a negative correlation between the average of dmft and glycemic control variables (such as the adherence to the nutritional plan p 0.012, rho -0.390, and glycemia p 0.017, rho -0.321), and with the frequency of toothbrushing (p 0.030, rho -0.383). There was also a negative correlation between salivary acidogenic activity and patient age (p -0.313, rho 0.029), and between the buffering capacity and the milliliters of salivary flow per minute (p - 0.308, rho 0.029).

Regarding the periodontal assessment, we only obtained a positive correlation between PI and SOHI (p 0.300, rho 0.033), PI and GI (p 0.336, rho 0.016), as shown in table 4.

Variable	PI (mean)	GI (mean)	GI categories (gingivitis mild/ moderate/severe)
Age			287 * 0.041
Therapeutic regimen (Usual/ intensified)	.323 * 0.021		
dmft			.339* 0.043
SOHI (mean)	0.300 * 0.033		
PI (mean)		0.336 * 0.016	0.281* 0.045

* The correlation is significant at the 0.05 level (bilateral)
** The correlation is significant at the 0.01 level (bilateral)

TABLE 4 Correlation between periodontal and general assessment variables.

Discussion

DM1 is a syndrome of abnormal carbohydrate, fat and protein metabolism that results in acute and chronic complications due to the absolute or relative lack of insulin. A large number of oral conditions have been associated with diabetes and other complications derived from this. The association between diabetes and periodontal disease has received the greatest attention, meanwhile other entities such as caries, salivary dysfunction, soft tissue pathologies, oral infections and other sensory disorders have received far less attention and even less in the paediatric DM1 population. The present study considered the analysis of the prevalence of caries, gingivitis, presence of dental plaque and the physicochemical qualities of saliva (pH, buffering capacity, acidogenic activity and salivary flow) and the association of these variables with the nutritional plan adherence and glycemic control in a paediatric population of diabetic patients.

The general distribution of DM1 observed in our study corresponds to the international trends, which report that the overall gender ratio is roughly equal in children [Soltesz et al., 2007]. Type 2 diabetes was recorded less frequently and mainly affected the female gender, a phenomenon consistent with global statistics reporting that most children with type 2 diabetes are over 10 years of age and it is infrequent in the prepubertal stage [Soltesz et al., 2007; Amutha et al., 2017]. Type 2 cases in this study were also related to variables such as BMI, weight and height.

An expected finding in our study population was the high percentage of the population with HbA1c values greater than their glycemic control target, since it has been observed to be a common pattern in this age group [Pinhas-Hamiel et al., 2014].

Regarding dentobacterial plaque control, a low level of oral health education was observed, since one-third of the population had not received previous dental care, and a high proportion did not perform daily brushing or performed it only once a day. This finding is reflected in the poor control of dental plaque, with plaque levels higher than that observed in other reports in populations of similar age [Lalla et al., 2006; Siudikienčet al., 2005], although Latino groups with poor hygiene conditions have also been reported to the present [Miranda et al., 2013], suggesting a trend according to the geographical and cultural context.

There is much controversy about the prevalence of dental caries in diabetic patients. Several studies with similar populations do not report statistically significant differences in the dmft/DMFT indexes between diabetic and healthy patients [Lalla et al., 2006] and our study cannot provide information in this regard because we did not include healthy subjects. With respect to dental caries prevalence, SIVEPAB (Mexico) in 2015 reported it was of 75% for children from 2 – 19 years old (for the overall population), higher than that in our study group. No data is available in the SIVEPAB report for each of the entities in the country, but the National Dental Caries Survey 2001 [NDCS, 2001] determined that the dental caries prevalence for 12 year-old children in the country was of 58% (with a mean DMFT of 1.91± 0.0688) while in Zacatecas it was of 53.87% for children from 6 to 10 years old (with a mean dmft of 1.45 ± 0.1086 and a mean DMFT of 0.24± 0.0234) and 43.12% for adolescents of 12 years (41.24%) and 15 years (45%) of age (with a mean DMFT of 0.75± 0.0728), so Zacatecas is one of the states with lower prevalence of dental caries in Mexico.

Additionally, we observed an increased prevalence of fluorosis (61%) in children and adolescents of this group, compared to the general population in Mexico (26.9% in 2015) [SIVEPAB, 2015]. The National Dental Caries Survey 2001 reported a fluorosis general prevalence of 27.9%, with a statistical significance difference among the states studied ($p < 0.0001$). For Zacatecas, the reported prevalence was 71.9% (76.4% for 12 years y 66.6% for 15 years of age). The highest Fluorosis Communitary Index (FCI) were reported for Durango (1.96), Zacatecas (1.19), Aguascalientes (1.10) and San Luis Potosí (1.0) [Betancourt-Lineares et al., 2013]. This data is variable according to the area, due to the different drinking water supply sources. In the metropolitan area of Guadalupe-Zacatecas (the state capital) Aguilera and colleagues estimated a fluoride concentration in tap water of 9.0 ppm and in bottled water of 3.0 ppm [Aguilera-Galaviz et al., 2009]. The presence of mild dental fluorosis has been associated to lower indices of dental caries, which might explain in part the reduced prevalence of caries in Zacatecas and particularly in our study group.

It has been reported that the prevalence and severity of gingival inflammation is higher in subjects with diabetes. The implications arising from the fact that our studied population showed a higher prevalence and a greater degree of gingival inflammation than those reported for populations with similar characteristics [Siudikienė et al., 2005] are of paramount importance. A strict educational programme for both the children and their caregivers needs to be implemented in order to reduce the impact on the prognosis of these patients regarding the possible loss of dental organs. The observed damage to the soft tissues could be explained by the presence of local factors since a positive correlation was observed between PI and GI. The biofilm located within or below the gingival sulcus interacts with the host immune system, resulting in the release of a broad array of inflammatory cytokines, chemokines and other inflammatory mediators. This leads to a gradual destruction of the supporting structures of the teeth and could be further aggravated by the fact that a severe immune impairment has been described in diabetics [Kjersti Skjold Rønningen and Morten Enersen, 2012; Boillot et al., 2015; Rivas et al. 2012]. On the other hand, there are studies like the one carried out by Lalla and colleagues in which the gingival index was higher in children with DM than in controls, both values were higher than in our study group in a similar age, which is very interesting, because ours showed worse hygiene conditions, higher HbA1c levels and an older age of the first dental appointment [Lalla et al., 2006]. These differences may be due to the ethnic origin of both populations as reported by Olczack-Kowalczyk and colleagues [Olczak-Kowalczyk et al., 2015]. Despite periodontal pocket depth measurement was not carried out because of WHO's recommendation of not using periodontal probes in children younger than 15 years old to avoid damage to the tissues, some of our patients presented tooth mobility and pockets, so it is desirable to implement a safety process to evaluate these periodontal signs for a better comprehension of the damage in diabetic paediatric population.

Xerostomia is a common sign in adult diabetic patients. The role of diabetes in the reduction of salivary flow remains unknown but probably angiopathy and neuropathy significantly contribute to the onset of salivary changes. Also, salivary flow may be affected by a variety of conditions, including the use of prescription medications and growing age in this group of patients. However, no definitive association between diabetes and reduced salivary flow has been identified in the paediatric population [Olczak-Kowalczyk et al., 2015]. In the present study, a lower salivary flow was observed in DM2 patients compared to DM1 individuals. In other populations with similar age to the present study group [Carneiro et al., 2015], the evaluation of stimulated salivary flow revealed that about 50% of the children had hyposalivation (<0.7ml / min), mainly those with HbA1c values greater than 8; our study recorded only 10% of hiposalivation in the patients examined. The implications of such reduction in the amount of saliva could affect the production of soluble antimicrobial mediators that are known to mitigate pathogen and microbial colonization.

The microbial colonisation as well as the onset and progression of oral diseases in diabetic patients may be modifying factors of the glycemic control and vice versa. It seems clear that poor glycemic control of diabetes increases the risk of diabetic complications as well as periodontitis and that diabetic patients with excellent glycemic control will have a reduced risk of diabetic complications including severe periodontitis. The data obtained in this study are not conclusive in relation to the influence of glycemic control elements on the presence of gingivitis, suggesting that there are other factors, such as those related to the patients' immunological response [Kjersti Skjold Rønningen and Morten Enersen, 2012]. Further research is needed in order to determine the influence of microbial products and mediators that could affect the insulin activity, given that several inflammatory mediators are known to reduce insulin sensitivity. The effect of oral hygiene improvement and education needs to be prospectively evaluated in this group of patients.

Children with diabetes are often given a diet that restricts their intake of carbohydrate and cariogenic foods, but it is a constant challenge to achieve a good adherence to this kind of diet [Kjersti Skjold Rønningen and Morten Enersen, 2012]. In the case of our study population different adherence patterns were detected according to the type of diabetes and the age of the participants. We observed a greater compliance in those with DM1 than in those with DM2. It was also possible to determine that as the percentage of adherence to the nutritional plan increases, the number of teeth with caries is reduced in temporary teeth, similarly to previous studies such as that

by Bassir and colleagues [Bassir et al, 2014; Tenovuo et al., 1986]. During the interview it was clear that most of the children consumed candies or other fermentable carbohydrates based treats and this was consistent with the high saliva acidogenicity records observed in the study group. According to the parents, the main reason was a limited access to a broader or more varied diet because of their low incomes but it is more probably due to a deficient nutritional education of the families. Better hygiene and nutritional education are therefore needed in these patients and their caregivers to improve both their diabetes control and also their oral health.

Conclusions

There was a significant relationship between diabetes mellitus and an increased prevalence of oral cavity related diseases in the paediatric population. These were also associated with a poor adherence to the nutritional plan and deficient oral hygiene, emphasizing the need of a health education plan. Despite the already proven bidirectional relationship and the oral health risks when suffering from DM, international protocols that dictate comprehensive care to diabetic patients do not consider nationwide strategies aimed at their prevention. Nevertheless, providing safe and effective oral medical care for patients with diabetes requires an understanding of the disease and familiarity with its oral manifestations.

Acknowledgements

Supported by the Project "Master in Biomedical Sciences of the Autonomous University of Zacatecas", by the Mixed Founding CONACYT Government of Zacatecas State, key ZAC-2013- C04 224230.

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