Oral Health of Portuguese Children with Type 1 Diabetes: A Multiparametric Evaluation

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Objective: *To perform a multiparametric evaluation of the oral health of 36 children with type 1 diabetes.* ***Study design:*** *A group of type 1 diabetic children and a sex-age-matched control group were formed. Seven parameters were evaluated: probing depth, bleeding on probing, plaque index (O'Laery index), calculus index (according to Ramfjord), dental caries (using ICDAS), salivary pH and unstimulated salivary flow rate. Statistical analysis was performed and the significance level was set at 5%.* ***Results:*** *Both groups consisted of 36 children with a mean age of 13 years. With regard to bleeding on probing, plaque index and calculus index, higher values were obtained in the diabetic group and the differences between groups were statistically significant for all three parameters. Concerning dental caries and salivary parameters, there were no significant differences between groups. However, a statistically significant correlation between salivary parameters and metabolic control was found.* ***Conclusion:*** *This study suggests that type 1 diabetic children are associated with some risk factors related to periodontal disease and dental caries. The proven relationship between diabetes and oral health complications imposes the need for these patients to be integrated into preventive dental programs from a young age.*

Key words: *diabetes, oral health, dental caries, periodontal disease, pediatric dentistry*

INTRODUCTION

Diabetes *mellitus* is a chronic metabolic disorder characterized by a deficiency in the production and/or action of insulin and it is associated with genetic, environmental and autoimmune factors. [1-3]

In 2008, the World Health Organization estimated that there were over 180 million people with diabetes, predicting that this number will double in the following 20 years.[4] About one third of people with diabetes are still undiagnosed.[5,6]

Diabetes can be classified into the following categories: Type 1 diabetes, in which there is a destruction of the pancreatic β-cells, resulting in decreased insulin production; Type 2 diabetes, which is associated with insulin resistance; gestational diabetes, in which the disease is diagnosed in the second or third trimester of pregnancy; and specific types of diabetes.[3,7]

About 75% of type 1 diabetics are diagnosed before the age of 18.[3] The first clinical signs of diabetes include polyuria, polydipsia, polyphagia and in severe cases ketoacidosis.[8,9] The main long-term complications of diabetes include retinopathy, nephropathy, peripheral neuropathy, autonomic neuropathy and sexual dysfunction.[3,8-12]

Periodontal disease is the most studied oral pathology associated with diabetes. Diabetics' response to pathogens responsible for periodontal disease is exacerbated. Moreover,

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pro inflammatory cytokines produced by gingival tissues during periodontal infection can enter the bloodstream, which can lead to an increased insulin resistance and consequently to an inadequate glycemic control.[5,13]

Dental caries is a multifactorial disease that is related to diet and to salivary flow rate and composition. These risk factors are commonly altered in patients with diabetes.[14,15] However, there is no clear evidence regarding the association between diabetes and dental caries. Some studies have found a higher prevalence of caries in diabetic compared with non-diabetic groups[14,16-18], others found a lower prevalence of dental caries[11,19-21] and some reported similar scores between groups.[22-25]

The aim of this study is to perform a multiparametric evaluation of the oral health of a sample of Portuguese children with type 1 diabetes. This evaluation includes probing depth, bleeding on probing, plaque and calculus indexes, prevalence of caries, salivary pH and unstimulated salivary flow rate.

MATERIALS AND METHOD

The Ethics Committee of the Faculty of Dental Medicine of the University of Oporto (Portugal) approved this study. Informed consent was obtained according to the Declaration of Helsinki and the confidentiality of the information collected was guaranteed.

A group of type 1 diabetic children and a group of children without diabetes (control group) were formed. All the children were consulted in the dental clinic of the Faculty of Dental Medicine of the University of Oporto. Each diabetic had a corresponding control of the same sex and age (maximum difference of one month).

Children with any syndrome or systemic disease associated with increased susceptibility to periodontal disease and/or related to salivary disorders, smokers, pregnant, with fixed orthodontic appliances and/or those who did not allow a proper assessment of their oral cavity were excluded.

The legal representative of every child answered a questionnaire that included information about medical and diabetes history and oral hygiene habits of his/her child.

A single observer performed the oral examination of the patients. This evaluation focused on all teeth, temporary and permanent, with the exception of the 3rd molar. Seven parameters were evaluated: Probing Depth (PD), Bleeding On Probing (BOP), Plaque Index (PI), Calculus Index (CI), dental caries, salivary pH and unstimulated salivary flow rate.

PI was evaluated according to the O'Laery index. To assess this index a disclosing tablet (GUM® Red-Cote®, Sunstar Americas, USA) was used. CI evaluation was done according to Ramfjord.

PD was assessed circumferentially using a periodontal probe with shades alternating every three millimeters. Six sites per tooth in occlusion were evaluated. The points where there was bleeding within 30 seconds after probing (BOP) were recorded. The prevalence of caries was assessed using the International Caries Diagnosis and Assessment System (ICDAS). The observer was calibrated by an experienced ICDAS examiner and expertise in cariology (inter-examiner agreement: k=0.93)

Every child was requested to drain all the produced saliva to a container for five minutes. The salivary volume was measured using a volumetric pipette. The salivary flow rate was calculated from the ratio between expelled saliva (in milliliters) and elapsed time (five minutes). For assessing salivary pH, pH Fix® strips (Macherey-Nagel, Germany) were used.

Statistical analysis was performed using SPSS v.22.0 IBM software (IBM Corporation, Amrnonk, New York, USA). Differences between groups were determined by applying chi-square/Fisher and Mann-Whitney tests. The Spearman correlation coefficient was also used to investigate the correlation between variables. The significance level was set at 5%.

RESULTS

The diabetic group consisted of 36 children with type 1 diabetes mellitus (18 females and 18 males) with a mean age of 13 years and four months. The control group consisted of 36 children without diabetes. Each diabetic had a corresponding control of the same sex and age (maximum difference of one month). No statistically significant differences were found between the groups with respect to age (p=0.971) and sex (p=1.000).

The average number of years since diabetes had been diagnosed was 5 years and 8 months (5.67±3.96) and the average percentage of glycated hemoglobin was of 8.39%–69.44% of the children were metabolically poorly controlled.

There were no statistically significant differences between the two groups regarding the number of times each child brushes their teeth. Most children (55.56% of the test group and 66.67% of the control group) brushed their teeth twice a day (p = 0.622).

Regarding toothbrush changing frequency and the number of dental appointments per year, there were no statistically significant differences between groups.

Only one child belonging to the diabetic group had a PD greater than 3mm. With regard to BOP, PI and CI, higher values were obtained in the diabetic group and the differences between groups were statistically significant for all three parameters (Table 1).

Table 1 – Evaluation of Bleeding on Probe, Plaque Index and Calculus Index

	Diabetic group	Control group	P value
BOP	35.66 ± 16.06	26.30 ± 13.88	0.010
PI	52.03 ± 2.04	38.25 ± 8.26	0.000
CI	0.14 ± 0.14	0.06 ± 0.06	0.000

BOP – Bleeding on Probe; PI – Plaque Index; CI – Calculus Index

A positive and statistically significant correlation between BOP and PI was found in the diabetic group (R=0.623, p=0.000) and in the control group (r=0.630, p=0.000).

A statistically significant and positive correlation between PI and CI was found in the diabetic group (R = 0.381, p = 0.022).

There were no statistically significant correlations between duration of diabetes and BOP, PI and CI. No statistically significant correlations between the percentage of glycated hemoglobin and BOP, IP and IC were found. Similarly, there were no significant differences between the periodontal parameters (BOP, PI, CI) and the salivary ones (pH and flow) in either group.

Regarding dental caries no statistically significant differences were observed. The average number of decayed teeth was 1.19 in the control group and 1.44 in the diabetic one. Only 0.06 teeth in the control group were missing due to caries vs. 0.11 in the diabetic group. Statistically significant differences between groups were found only regarding the number of filled teeth (p=0.024)–the control group had an average of 1.56 teeth restored while the average was 2.72 in the diabetic group.

The sum of decayed, missing due to caries and filled teeth did not show a correlation with salivary pH or with unstimulated salivary flow rate in either group. A correlation between metabolic control and the number of decayed, missing and filled teeth was not found.

Concerning salivary pH and unstimulated salivary flow rate, there were no statistically significant differences between groups (Table 2).

Table 2 – Evaluation of salivary pH and unstimulated salivary flow rate

	Diabetic group	Control group	P value
Salivary pH	6.82 ± 0.26	6.88 ± 0.21	0.343
Unstimulated salivary flow rate (ml/min)	0.33 ± 0.15	0.36 ± 0.12	0.398

A statistically significant positive correlation between salivary pH and unstimulated salivary flow rate was found in the two groups, being a moderate correlation in the diabetic group (R=0.533, p=0.001) and a week one in the control group (R=0.356, p=0.033).

A statistically significant correlation between salivary pH and the percentage of glycated hemoglobin was found–the higher the glycated hemoglobin, the lower the salivary pH (R=-0.355, p=0.033).

A negative correlation with statistical significance between unstimulated salivary flow rate and glycated hemoglobin was found, which means that the higher the percentage of glycated hemoglobin, the lower the salivary flow rate (R=-0.376; p=0.024).

DISCUSSION

The various systemic changes resulting from diabetes affect the periodontium and there are several studies that prove this relationship.[8,11,25,26]

BOP is considered an indicator of periodontal inflammation since it is associated with cellular and tissue changes that are typical of the inflammatory process. Studies on the subject noticed that in areas where there's BOP there's a higher percentage of lymphocytes, monocytes and macrophages.[27-29]

Patients with type 1 diabetes have an exaggerated gingival inflammatory response to pathogenic microorganisms.[11] Furthermore, diabetic patients have a greater gram-negative anaerobic bacterial load as compared with non-diabetic patients, which are the major bacteria associated with periodontal disease.[25,30] On the other hand, there are vascular abnormalities resulting from prolonged exposure to hyperglycemia that prevents oxygen diffusion, decrease the elimination of metabolites and changes leukocyte migration and diffusion of immune factors, which may lead to an increased BOP.[11,30]

In this study, similarly to what was found in many others[8,25,31,32], a higher BOP in the diabetic group was found, which suggests the existence of a higher gingival inflammation. Bacterial plaque accumulation can initiate gingival inflammation. Bacteria from dental plaque release a variety of substances such as endotoxins, chemotactic peptides and toxins. In turn, these products stimulate various responses by the host such as the release of chemokines (including IL-1β, IL-8, prostaglandins and TNF-α).[33]

Different studies have also found a greater accumulation of bacterial plaque in children and adolescents with type 1 diabetes.[11,18,25,32,34,35] One common explanation for this result is the decrease of salivary flow rate, often observed in patients with type 1 diabetes.[36,37] However, no relationship was found between these two parameters in this study. Another possible explanation for the greater amount of bacterial plaque in the diabetic group is that diabetics have more meals.[25] Nevertheless, there are also studies reporting lower PI values in diabetics.[38,39]

In this study, as well as in similar others, it was found a greater calculus accumulation in children with type 1 diabetes.[11,18,25,38] The greater calculus formation in diabetic patients can be explained by an increased salivary calcium concentration, as well as an increase of salivary proteins and urea.[11,39]

The association between BOP and PI was expected since bacterial plaque is a causative factor of gingival inflammation.[27,38]

The elapsed time since diagnosis of diabetes is often associated with increased periodontal disease severity.[25,31] However, different studies[26,32] (including this one) could not verify this correlation, which may relate to the fact that only children were observed.

Similarly, metabolic control has been pointed out as a factor that influences periodontal disease severity. A great number of studies have proven this correlation.[18,25,26,31] Several reasons have been cited in order to justify the existence of this association, including: 1) hyperglycemia which can alter the function of neutrophils and cause changes in collagen's metabolism and thus in the normal healing process; 2) the increase of glucose concentration in crevicular fluid and blood may change oral microbiome, which may contribute to an increased severity of periodontal disease.[38]

It was also found a statistically significant negative correlation between glycated hemoglobin and salivary pH and salivary flow rate. These results are consistent with other studies suggesting that a poor metabolic control promotes quantitative and qualitative changes in saliva, which present risk factors for dental caries.[15,40,41]

Despite the high percentage of metabolically poorly-controlled children, no statistically significant differences were found between groups concerning the sum of decayed, missing due to caries and filled teeth. Some studies found similar results.[25,42]

Bassir *et al*[25] haven't found significant differences between 31 diabetic children and adolescents and 31 sex-age-matched controls regarding dental caries. However, after assessing their dietary habits, and despite diabetics' greater number of daily meals, they include in their diet fewer cariogenic foods, giving them a dietary score significantly lower than that the one of the control group (7,65±3.27 vs. 11.94±2.03).[25] Referring similar results, Amaral *et al*[21] found a lower caries index in the diabetic group associated with better dietary habits, with lower intake of cariogenic products.

However, there are also studies reporting a higher incidence of caries in metabolically poorly-controlled diabetic children. Twetman *et al*[43] observed 28 newly diagnosed diabetic children over a period of two years and reported that HbA_{1c} values were higher in children who developed caries lesions during the study period. The incidence of caries lesions was significantly higher in the first year, which can reflect the beneficial effect of diabetics' dietary changes.[43]

Though diabetics often have a larger number of meals *per* day, they usually have restrictions on the intake of carbohydrates.[25] On the other hand, parental overprotection is commonly seen in children with chronic diseases[14] which can also justify the results.

CONCLUSION

Some specific aspects of diabetes (as oral health) have been poorly explored, particularly in Portugal. As far as the authors know no data regarding the relationship between type 1 diabetes and oral health in Portuguese children was ever published.

The proven relationship between diabetes and periodontal disease imposes the need for these patients to be integrated into preventive dental programs from a young age. Although this study failed to find a significant difference between diabetics and controls regarding the prevalence of dental caries, it was found a negative correlation between the percentage of glycated hemoglobin and salivary flow rate and salivary pH, which demonstrates the importance of metabolic control as a risk factor in the development of salivary changes and therefore dental caries.

The creation of new oral health policies directed to these patients and of educational programs aimed to inform them about diabetes' consequences on oral health is of a great importance.

Research should continue to be done so that a dental program based on scientific evidence could be offered to these patients, aiming not only treatment but also prevention.

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 doi 10.17796/1053-4628-42.3.12