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Oral health status of children with type 1 diabetes: a comparative study

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Abstract

Background: The aim of this study was to compare the oral health status of children with type 1 diabetes and healthy controls.

Methods: This comparative study involved 64 children, 32 children with type 1 diabetes and 32 age- and gender-matched controls. Oral health examination was conducted using WHO criteria. Dental caries experience was recorded using DMFT/dmft index and periodontal parameters were assessed using plaque, gingivitis, gingival bleeding and calculus indexes. Dental caries and periodontal parameters between the two groups were compared using the Mann-Whitney U-test.

Results: Children with diabetes exhibited significantly greater plaque deposits ($p = 0.01$) and a higher mean plaque index ($p < 0.01$), when compared to healthy subjects. No significant difference in DMFT and dmft scores, mean bleeding index, calculus index and gingival index was found between the two groups.

Conclusions: Children with type 1 diabetes had a poor oral health status with greater plaque accumulation than children without diabetes.

Keywords: caries; children; oral health; periodontal health; type 1 diabetes.

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Introduction

Diabetes mellitus is a chronic metabolic disease, with two basic types, which are insulin-dependent diabetes mellitus (type 1) and non-insulin-dependent diabetes mellitus (type 2) [1]. Type 1 diabetes mellitus is an endocrine metabolic disease, characterized by hyperglycemia as a cardinal biochemical feature [2]. The disease is a recognized chronic disease with a high incidence in Europe and a low incidence in Asia [3]. There is concern over a rising incidence of children with type 1 diabetes in many countries [4–7]. The current concept of diabetes management includes blood glucose monitoring, insulin administration, modified lifestyle and diet [2]. The glycosylated hemoglobin (HbA_{1c}) level provides a reliable index for measurement of glycemic control in diabetes. HbA_{1c} reflects the average blood glucose concentration of the patient with diabetes in the past few months, with a lower HbA_{1c} level indicating better metabolic control [2].

When compared to the healthy population, individuals with type 1 diabetes have a higher risk of dying prematurely [8] or within a few years after diagnosis [9] and have lower health-related quality of life (HRQOL) [10]. Patients with type 1 diabetes are associated with numerous comorbidities with a high mortality rate [11]. One of the complications of diabetes mellitus is microangiopathy, which affects tissues with rich capillary vessels [12]. This effect was also evident in oral tissues and oral health [13]. The association between diabetes mellitus and periodontal health has long been studied and it is suggested that individuals with type 1 diabetes mellitus are at an increased risk of developing periodontal disease [12, 14–16]. On the other hand, the association between type 1 diabetes mellitus and dental caries has been given less attention with conflicting evidence among studies. While some studies have reported higher caries experience among children with diabetes [17–19], others reported no significant difference in caries experience between the healthy children and children with diabetes [15, 20, 21].

With this conflicting evidence on the oral health of children with type 1 diabetes, the aims of this study were to compare the caries experience and periodontal health status between children with type 1 diabetes and healthy age- and sex-matched controls. The null hypothesis was

that there were no significance differences in oral health parameters between those with and without diabetes.

Materials and methods

Sample size

The study was approved by the local Institutional Review Board (IRB reference number: UW 12-344). The estimated sample size for this study was calculated based on the key outcome measure of plaque findings of Orbak et al. [12] with a mean difference of 0.71 in plaque index. Based on this assumption with type 1 error of 5% and type 2 error of 20% using G*power software version 3.1.7 (Franz Faul, Universitat Kiel, Germany), a sample size of 32 was required for each group to meet the parameter.

Individuals with type 1 diabetes, who are members of the Hong Kong Juvenile Diabetes Association, were recruited to participate in this comparative study and were invited to attend the University Paediatric Dentistry Clinic with their parents for a dental examination. On the day of clinical examination, both the parents and individuals with diabetes were given the patient information sheet and were informed about the aims and nature of the study, before signing the consent form. Data regarding the level of diabetic metabolic control and HbA_{1c} level were collected from the parents. For the control group, an age- and gender-matched sample of clinically healthy patients attending the same dental clinic for treatment was recruited. The recruited control subjects did not have any systemic disease or problems with manual dexterity, were not undergoing active orthodontic treatment, and had not received any comprehensive dental treatment for the past 1 year.

Dental examination

Dental examination was performed by a single trained and calibrated examiner in a dental chair using a dental mirror, dental explorer and periodontal probe under light from the dental chair. All the participants were examined during the morning sessions from 8:30 am to 11:30 am following the protocol of Firatli [22]. All the data were recorded on a clinical form for each participant.

Dental caries: The dental caries status of the participants was assessed using DMFT/dmft index [23]. All the primary and permanent teeth were examined for caries using visual examination. No bitewing radiographs were taken and no laser-assisted caries detector was used to assess dental caries. DT/dt referred to the number of decayed permanent/primary teeth, MT/mt referred to the missing permanent/primary teeth due to caries and FT/ft denoted the filled permanent/primary teeth, respectively.

Periodontal parameters: The periodontal parameters of the participants were measured using the plaque index [24], the gingival index [25], the gingival bleeding index [26] and the calculus index [27]. The dentition was divided into six sextants, with one index tooth determined to represent each sextant, which are maxillary right first molar, maxillary right lateral incisor, maxillary left first bicuspid, mandibular left first molar, mandibular left lateral incisor and mandibular right first bicuspid as proposed by Loe and Silness [25]. Index teeth that were missing, mobile or unerupted were excluded from examination. After the dental examination, all children received a full-mouth scaling using an ultrasonic scaler, followed by prophylaxis with a rubber cup and pumice on a low-speed handpiece from the examiner. The examiner also gave oral hygiene instructions to all patients individually.

Statistical analysis

All the data collected were analyzed using SPSS version 20.0 software (SPSS Inc, Chicago, IL, USA). The means and standard deviations were calculated for the continuous data. Differences in the caries experience and periodontal parameters between the diabetics and the controls were compared using the Mann-Whitney U-test following normal data distribution. Variation in oral health status with regards to metabolic control level of the diabetic children was determined using the Mann-Whitney U-test. Statistical significance was considered when $p < 0.05$. The data recorded on the clinical form were repeated for each individual on the same day at two different occasions by the same examiner for intra-examiner reliability assessment [28]. Both data were analyzed for intra-class reliability using one-way random model on SPSS software.

Results

A total 32 members (16 boys and 16 girls) from the Hong Kong Juvenile Diabetes Association attended the University Paediatric Dentistry Clinic for dental examination. The mean age of both the individuals with diabetes and the controls was similar at 12 ± 4 years with no significant difference between the two groups ($p > 0.05$). The mean HbA_{1c} level of the diabetics was $7.51 \pm 1.28\%$ (ranged from 5.0% to 10.6%), indicative of good metabolic control in type 1 diabetes management [2]. Among the 32 diabetic children, 84.3% (n = 27) fall under '*good metabolic control*'; while 6.3% (n = 2) and 9.4% (n = 3) fall under the '*fair*' and '*poor metabolic control*', respectively. No statistical significant difference in the prevalence of malocclusion was found between the two groups ($p > 0.05$). The kappa scores for caries and periodontal health assessments were 0.876 and 0.985, respectively. The demographic characteristics of individuals with diabetes and the controls are summarized in Table 1.

The caries status of the individuals with diabetes and the controls is presented in Table 2. Both the mean DMFT and dmft scores of the individuals with diabetes were lower than the controls, though the differences were not statistically significant ($p > 0.05$). Conversely, no significant difference in the overall mean DMFT + dmft

Table 1: Demographic characteristics of diabetic and non-diabetic children.

	Diabetics	Non-diabetics
Age	12 ± 4 years	12 ± 4 years
Gender (M:F)	16:16	16:16
Medical comorbidities	Type 1 diabetic only	Healthy
Glycemic control, %		
good:fair:poor	84.3:6.3:9.4	–
Family median income[a], %		
lower:higher	59.4:40.6	65.6:34.4
History of orthodontic treatment	No	No
History of comprehensive dental treatment	No	No
Malocclusion[b], %		
present:absent	87.5:12.5	90.63:9.37
Parental education level, %		
below tertiary:tertiary and above	31.2:68.8	37.5:62.5

[a]Based on Hong Kong Poverty Situation Report 2012, Government of Hong Kong SAR. [b]Based on British standard classification of incisor relationship 1983.

Table 2: Caries experience of diabetic and healthy non-diabetic controls.

	Mean (SD)		p-Value
	Diabetics	Non-diabetics	
DMFT	1.69 (1.75)	2.03 (1.75)	0.44
DT	0.56 (0.84)	0.31 (0.59)	0.17
MT	0 (0.0)	0 (0.0)	
FT	1.13 (1.34)	1.70 (1.46)	0.10
dmft	1.09 (2.43)	1.38 (2.71)	0.66
dt	0.53 (1.85)	1.28 (2.54)	0.18
mt	0.31 (1.00)	0 (0.0)	0.09
ft	0.25 (0.98)	0.09 (0.30)	0.39
DMFT/dmft	2.78 (2.56)	3.41 (2.27)	0.31
DT/dt	1.09 (1.87)	1.59 (2.45)	0.36
MT/mt	0.31 (1.00)	0 (0.0)	0.09
FT/ft	1.38 (1.64)	1.81 (1.38)	0.25

Significant difference at $p < 0.05$, Mann-Whitney U-test.

Table 3: Periodontal health status of diabetic and healthy non-diabetic controls.

	Mean (SD)[a]		p-Value
	Diabetics	Non-diabetics	
Plaque	0.66 (0.46)	0.43 (0.16)	0.01[b]
Gingival bleeding	0.20 (0.18)	0.16 (0.11)	0.35
Calculus	0.10 (0.13)	0.10 (0.13)	0.89
Gingivitis	0.50 (0.35)	0.51 (0.22)	0.90
Plaque index	0.76 (0.40)	0.46 (0.14)	<0.01[b]
Bleeding index	0.20 (0.18)	0.16 (0.11)	0.35
Calculus index	0.14 (0.15)	0.13 (0.15)	0.86
Gingival index	0.58 (0.36)	0.62 (0.29)	0.69

[a]Mean percentage of sites with scores >0, [1.00 = 100%]. [b]Significant difference at $p < 0.05$, Mann-Whitney U-test.

values was observed between individuals with diabetes and the controls ($p > 0.05$). No permanent teeth were extracted due to caries in either the group with diabetes or the control group. By contrast, 10 children with diabetes (31%) had primary teeth missing due to caries; whereas no children in the control group had missing primary teeth. However, the mean MT and mt scores were not significantly different between the two groups ($p > 0.05$). Filled teeth contributed to most of the caries experience in the permanent dentition of the individuals with diabetes (FT = 1.13 ± 1.34, 67%) and the controls (FT = 1.70 ± 1.46, 84%). By contrast, decayed teeth caused most of the caries experience in primary dentition of the individuals with diabetes (DT = 0.53 ± 1.85, 49%) and the controls (DT = 1.28 ± 2.54, 93%). In children with type 1 diabetes, 28.1% (n = 9) were caries free as compared to only 12.5% (n = 4) in the control group.

The periodontal parameters of the children with diabetes and the controls are presented in Table 3. The children with diabetes had a greater percentage (66 ± 46%) of sites with visible plaque deposition, when compared to the controls (43 ± 16%) ($p = 0.01$). The children with diabetes also had a greater percentage of sites with 'bleeding on probing' than the control group; though the difference was not statistically significant ($p > 0.05$). The percentage of sites with gingivitis and calculus deposits was similar in both the children with diabetes and the healthy controls ($p > 0.05$). The mean plaque index of the children with diabetes (0.76 ± 0.40) was also significantly higher than that of the healthy controls (0.46 ± 0.14) ($p < 0.01$). No significant

difference in mean bleeding index, calculus index and gingival index was found between the two groups.

Discussion

According to the Hong Kong childhood diabetes register [29], the incidence rate for children with type 1 diabetes aged 0–4 years was 0.9 per 100,000 per year and for 10–14 years old was 1.7 per 100,000 per year. Recent data by Huen et al. [30] showed that the incidence rate of childhood diabetes had increased for the <15 years old group to 2.4 per 100,000 per year. Children with type 1 diabetes are considered as one of the high-risk groups in relation to compromised oral health [15]; hence, provision of regular dental care to this special needs group is indicated to improve and maintain good oral health.

The present study evaluated and compared the oral health status of children with type 1 diabetes with the healthy control group. The sample age of our subjects varied considerably, from 4 to 17 years, with a mean age of 12. Our study adopted the metabolic control classification proposed by Alemzadeh and Wyatt [2], which classified the diabetics as '*good metabolic control*' when their HbA_{1c} level ranged from 6 to 8.5%, '*fair metabolic control*' when their HbA_{1c} level was 9–10% and '*poor metabolic control*' when their HbA_{1c} level was 11% or higher. Our present study was limited due to the small number of '*not well-controlled*' diabetic subjects, with only 15.7% (n = 5) in the group with diabetes. The small number of individuals with diabetes with poor metabolic control might be attributed to the self-reported glycemic level of the children with diabetes by the parents/guardian. In calculation of sample size, the key outcome measure of plaque was chosen as diabetic response to plaque was established.

With regard to the caries experience, the present study did not find any significant difference between the children with diabetes and the healthy children in both the primary and permanent dentitions. Our result was in agreement with Lalla et al. [31], Swanljung et al. [21] and Goteiner et al. [32]. Our control subjects exhibited slightly higher caries experience, when compared to the children with diabetes. This might be due to our control sample, which was recruited from children attending the University Paediatric Dentistry Clinic, seeking dental treatment. When comparing the results of our study with the Oral Health Survey conducted recently on the 12-year-old school children in Hong Kong [33], the mean DMFT for the group with diabetes (1.69 ± 1.75) and the control (2.03 ± 1.75) group was found to be much higher (0.4) than the survey group.

Results of the present study also showed that children with type 1 diabetes had a significantly higher percentage of sites with plaque compared to the control group. This result concurred with the findings by Orbak et al. [12], Al-Khabbaz et al. [14] and El-Tekeya et al. [15]. This finding might be attributed to the reduced salivary flow [17] and competing health concerns among children with diabetes. Our results also support the study by Carranza and Newman [34], which showed a positive correlation between plaque accumulation and gingival bleeding, with a higher percentage of gingival bleeding among children with diabetes, although it was not statistically significant.

For gingival inflammation, our study shared similar results with that of Goteiner et al. [32], whereas others studies [12, 14, 15, 31] found significant difference between children with type 1 diabetes and controls. For calculus parameters, our study found similar percentages of calculus distribution between the children with type 1 diabetes and healthy controls. Alves et al. [17] found no significant difference in calculus index between the two groups; while Orbak et al. [12] and Siudikiene et al. [16] showed that children with diabetes had significantly higher calculus index compared to control, healthy children. When comparing the periodontal results of our subjects with that of the 12-year-old school children in Hong Kong [33], the mean percentages of plaque deposition in the children with diabetes (66 ± 46%) and controls (43 ± 16%) were much higher than that of the 12-year-old school children (27%) in Hong Kong.

To date, very few studies have monitored the oral health status of children with type 1 diabetes longitudinally [22, 35]. As diabetes is a chronic disease, future studies should monitor the oral health status of individuals with diabetes with different metabolic levels over time. This will provide the dental health personnel with a better understanding of the oral health problems and treatment needs of the children with type 1 diabetes and thus benefit both the patients and clinicians. It would also be useful to investigate the effect of oral health promotion initiatives focused on improving the oral health of children with diabetes, in addition to their metabolic control.

Conclusions

In conclusion, children with type 1 diabetes had poor oral health status with greater plaque deposition.

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