THE INTERRELATION BETWEEN ORAL HEALTH STATUS AND SERUM GLYCATED HEMOGLOBIN LEVELS AMONG SCHOOLCHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES MELLITUS

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ABSTRACT

Objective: This study aimed to evaluate the effects of metabolic control on oral health status among diabetic children and adolescents.

Methods: The sample in this study consisted of 60 school adolescents diagnosed with T1DM aged 12-18 years, divided into two groups of 30 subjects each: group A consisted of patients with well-controlled glycemia and group B of those with poor metabolic control. Plaque index and Gingival index according to Sillnes and Löe, and measurement of alveolar bone loss was used to assess the level of oral hygiene and periodontal health. DMFT was used to estimate caries status.

Results: Subjects with poor metabolic control had significantly more plaque accumulations with a mean PI score of 1.87 in group B vs 1.33 in group A. Gingival inflammation was more frequent and severe in group B. Alveolar bone resorption was recorded in 46,67% subjects with poor metabolic control and in 30% subjects with well-controlled glycemia.

Mean DMFT was not significantly different between groups, i.e. 10.57 and 12.39 for groups A and B respectively, although patients in group B had significantly more extracted teeth, almost as twice as in group A.

Conclusion: Significantly higher amounts of dental plaque and more severe gingival changes in children with poor metabolic control indicate the need for early screening of risk factors for periodontal disease. More frequent extractions in these patients indicate negative health behaviors and irregular dental attendance, both of which require correction through education and motivation to establish good oral health habits.

Keywords: T1DM, metabolic control, HbA1c, periodontal health, caries, alveolar bone

Introduction

Diabetes mellitus (DM) has been recognized as a public health problem since the 1970s. [1] Between 1995 to 2010, the incidence of type 1 diabetes mellitus (T1DM)) in children under 15 years of age increased by 4.36%, and this increase was particularly pronounced after 2006 [2]. It is currently estimated that annually about 96,000 young people under 15 years of age develop T1DM globally [3]. Type 1 diabetes mellitus accounts for over 90% of diabetes that occurs in childhood and adolescence [4]. Furthermore, according to a study reported in Lancet, there is a higher increase in the incidence of this disease in developing countries or those that have just undergone economic transition. [5]

T1DM is a chronic metabolic disorder characterized by hyperglycemia. In adults as well as in pediatric patients, the metabolism of carbohydrates, fats and proteins is disrupted due to insufficient insulin secretion. The manifestation of the disease is preceded by a long-lasting, covert autoimmune process of selective destruction of pancreatic beta cells, known as pre-diabetes [6]. It is generally known that untreated uncontrolled diabetes can cause complications on almost all organs in the human body, and the most commonly affected are the heart and blood vessels, eyes, kidneys, nerves and gastrointestinal tract. These complications are mainly due to microvascular and macrovascular damage. A number of oral complications of this disease have also been described in the scientific literature, among which the most frequently mentioned are: increased caries risk, greater susceptibility to periodontal disease, more frequent opportunistic infections (e.g. Candidiasis), and xerostomia [7]. Oral complications are the result of the long-term effects of diabetes and therefore are classified as chronic complications. DM exerts its influence on periodontal tissue through vascular damage, similar to the retina, neural and renal tissue [8]. There is ample scientific evidence that children and adolescents suffering from T1DM compared with healthy children have more gingivitis as well as a higher prevalence and a more progressive form of periodontitis [9, 10, 11]. The existence of an interrelation between diabetes and periodontitis has been established in a way that diabetes increases the risk of periodontitis, but at the same time, the existing periodontal disease makes optimal glycemic control more difficult to maintain. [12, 13]

When it comes to caries, patients with T1DM have multiple risk factors that could lead to an increase in the incidence of this disease. These are primarily the acidity of saliva, i.e. pH that reaches a lower level than in healthy patients, as well as reduced salivary flow leading to slower carbohydrate clearance and increased concentration of glucose in saliva. As a consequence, elimination of dental deposits is impeded being especially expressed at night. [14, 15, 7]

Besides, due to the nature of the disease, these patients often eat more frequently thus exposing dental tissues to more frequent episodes of demineralization. [16,17]

However, reducing dietary carbohydrates to maintain glycemic control can lead to a reduced occurrence of caries in diabetics. This might explain the controversial results of numerous studies looking for answers on whether and in what way does DM influence caries experience.

Recent systematic research [18] reported that while 11 studies found higher caries rate among T1DM patients, four of them had opposite results reporting lower mean DMFT values than in healthy controls, and even 20 studies found no significant difference. Studies that attempted to evaluate the effect of the metabolic control in dental caries occurrence, also gave similarly diverse results, especially when blood concentration of glycated hemoglobin (HbA1c) cut-off of 7% has been used. [18, 19]

HbA1c is a specific retrospective index of glucose regulation in patients with diabetes mellitus. Its values for our region are determined as follows [20, 21, 22]:

- proper glycemic control — HbA1c is $\leqslant 7\%$
- poor glycemic control — HbA1c is $> 7\%$.

Given previous research results, this study aimed to evaluate the effects of metabolic control on oral health status among diabetic children and adolescents using the 7% HbA1c cut-off level.

Material and Methods

Subjects

The study sample consisted of 60 school adolescents diagnosed with T1DM aged 12-18 years. They were diagnosed at the Endocrinology department of Pediatric Clinic in Sarajevo, where the recruitment of these subjects was done.

Two groups of participants were formed, each comprising of 30 subjects: group A consisted of patients with well-controlled glycemia (HbA1c⩽ 7%) and group B consisted of those with poorer metabolic control (HbA1c>7%). The data on metabolic control were obtained from patient medical records.

Recruitment of patients was done according to exclusion and inclusion criteria.

Inclusion criteria were the acceptance to participate in the study and that T1DM was diagnosed at least two years before the study.

Orthodontic patients, those with multiple non-carious dental lesions, and those that had professionally applied topical fluorides within the previous 6 months or that used antibiotics and/or oral antiseptics during the previous 2 weeks were excluded from the recruitment process.

Thirty consecutive patients with poor metabolic control (group B) and 30 consecutive patients with well-controlled glycemia (group A) that attended the Endocrinology department for a regular check-up and met all the criteria, were referred to the Pediatric Dental Department of the Sarajevo Canton Public Health Centre.

Ethical considerations

Ethical Committee of the Faculty of Dentistry University of Sarajevo approved the study design. After the methods and aim of the research were presented to the parents/guardians, informed consent was signed. All patients received necessary dental treatment upon the examinations.

Dental examination:

Clinical examinations were performed in the dental chair, using a straight dental mirror and the World Health Organization (WHO) periodontal probe. One dentist performed all the examinations.

Dental status was assessed using the DMFT index that scores decayed – untreated carious teeth (D), missing (M), and filled (F) teeth.

The teeth with clearly visible cavitated caries lesions, those with caries adjacent to filling and all temporary fillings were recorded as decayed, whereas enamel demineralization with intact surfaces was considered intact teeth. Only teeth extracted due to caries were recorded as missing, and teeth with intact definitive fillings were denoted as filled. [23]

Oral hygiene was assessed according to the Plaque Index (PI - Silness and Löe,1964), whereas Gingival Index (GI - Löe and Silness,1963) was used to determine the condition of the gingiva. The teeth used for the evaluation were: 16, 11, 26, 36, 31, and 46, and scores were recorded for mesial, distal, buccal and lingual surface. Plaque quantity was assessed along the cervical portion of teeth.

Alveolar bone resorption was assessed using orthopantomogram x-rays since periodontal pocket probing is not indicated for patients younger than 15 years 23. Distance between the cementoenamel junction (CEJ) and the alveolar bone margin (BM) was measured, and all findings that were ⩾ 3 mm were recorded as the presence of bone resorption. If the distance was less than 3 mm it was considered as negative evidence of bone loss.

Statistical analysis

Data were analyzed using Microsoft Office Excel. Descriptive data were presented as Mean ± SD (standard deviation) or the percentages. The differences between groups were assessed by using the Student t-test. The differences were considered significant if the p value was less than 0.05.

Results

Sample

Subjects in this study were T1DM patients aged 12 to 18 years, divided into two groups according to their metabolic control. The mean age in group A (good metabolic control) was 15.97 ± 1.59 years, and 15.63 ± 1.99 in group B (poor metabolic control). There was no significant difference in respect to age between groups ($t = 0.79$, $p > 0.05$).

The average duration of T1DM in patients in group A was 8.87 ± 3.13 years, and 8.37 ± 3.12 in group B. T-test did not reveal a significant difference either ($t = 0.61$, $p > 0.05$).

Caries status

The proportion of filled and decayed teeth was almost equal in group A, 46.06%, and 45.43%, respectively, while the proportion of extracted teeth was 8.52%.

In group B, there were 46.24% decayed teeth recorded, followed by 37.37% filled teeth and almost as twice extracted teeth (16.4%) as in group A.

Mean DMFT values with its components are shown in **table 1.**

Mean DMFT score in subjects in group A was lower than in those in group B. However, the difference was not statistically significant. Patients with better metabolic control had significantly lower M component value than those with poor control ($t=2.69$, $p<0.05$). Components D and F did not differ considerably between groups.

Variable	group A (HbA1c ⩽ 7) (n = 30) Mean (SD)	group B (HbA1c > 7) (n = 30) Mean (SD)	P value
DT	4.80 (3.59)	5.73(3.16)	p >0.05
MT	0.90(1.24)	2.03(1.90)	p <0.05
FT	4.87(2.61)	4.63(2.44)	p >0.05
DMFT	10.57(3.22)	12.39(2.97)	p >0.05

Table 1.
DMFT and its components scores

Plaque Index (PI)

The mean PI score was significantly higher among subjects with poorly controlled glycemia (group B), which is shown in **table 2.**

In group A the highest individual PI score recorded was 2, while in group B this value went up to 3.

Group	n	Mean ± SD	t	P
A	30	1.33±0.66	t=2.92	P <0.01
B	30	1.87±0.73		

Table 2. Mean Plaque Index scores

Gingival Index (GI)

In total sample, healthy gingiva without inflammation was recorded in only 8.3% of subjects, mild inflammation in 28.3%, moderate inflammation in 56.7% and severe inflammation in 6.7% of subjects. (**Figure 1**.)

The mean value of the Gingival Index in group B is significantly higher than in group A. In 4 subjects with poor metabolic control Gingival Index score amounted to 3 (severe inflammation), while in patients with well-controlled glycemia the highest recorded score was 2 (moderate inflammation).

Group	n	Mean ± SD	t	P
A	30	1.37±0.67	t=2.72	P <0.01
B	30	1.87±0.73		

Table 3. Mean Gingival Index scores

Alveolar bone resorption

Subjects with poor glycemic control as compared to those with proper control tended to

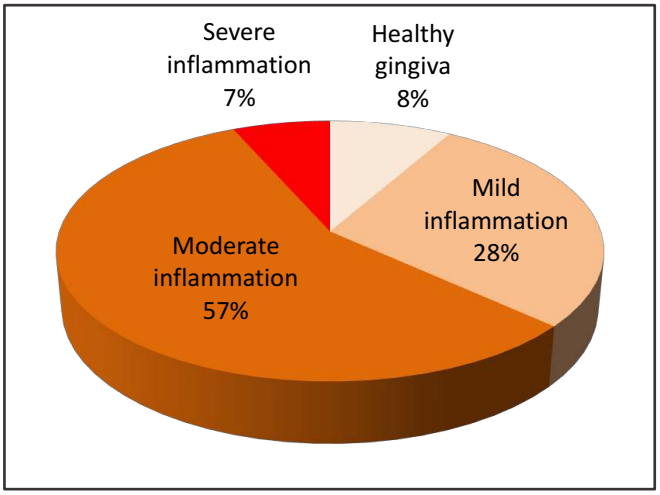

Fig. 1. Gingival index in the total sample (n=60)

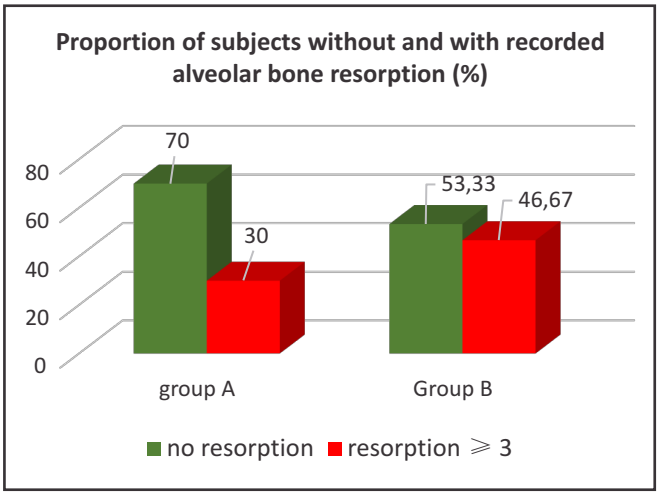

Fig 2. Alveolar bone resorption

show a higher frequency of loss of alveolar bone. The findings are shown in **Figure 2.**

Discussion

The results of this study demonstrated high DMFT values in children and adolescents with T1DM, regardless of metabolic control. The obtained DMFT values in both groups: 10.57 (SD±3.22) in well-controlled patients and 12.39 (SD±2.97) in patients with poor metabolic control, according to the WHO categorization, represent a high severity level [25]. For comparison, the average DMFT of twelve – and fifteen-year-olds in the general population in Bosnia and Herzegovina was reported to be 4.2 (SD±2.9) and 7.6 (SD±4.1) respectively [26].

Unlike a periodontal disease, which is a rather well-documented complication of DM [9, 11, 12, 13, 27], the impact of this metabolic disease on caries development, despite numerous studies, is still not fully elucidated, as the research results are very inconsistent. A recent systematic review [18], as noted in the introductory section, analyzed 35 studies comparing the association of DM and caries and reported that conclusions ranged from those that DM patients had a higher incidence, to those that diabetics had fewer caries lesions, or no difference between diabetics and the healthy controls was reported. Similar results were demonstrated by a systematic review of studies on the oral health of adolescents with T1DM, listing 5 studies indicating a significantly higher experience of caries in subjects with type 1 Diabetes Mellitus compared to healthy controls, 3 studies showing significantly lower values, and 7 studies reporting that there was no difference between the two groups [28].

Explanations could be sought in the multifactorial nature of caries, which is why different aspects of DM can affect development of this oral disease in different directions. Complex interactions of several factors such as reduced amount and flow of saliva, its buffering potential, as well as composition and quality of oral microflora should be considered. Plaque deposits, quality of nutrition and dietary patterns, socio-demographic factors, practices and attitudes related to oral health might also play an important role [7].

Considering the correlation between metabolic control levels and caries rates, which was the subject of this paper, most studies report that well-controlled diabetics have fewer decayed teeth and lower caries incidence and prevalence [29-33].

In our study, the mean value of DMFT in a group with poor metabolic control was somewhat higher compared to well-controlled patients, however, the difference was not statistically significant. This is in line with a study conducted by El-Tekeya et al. [34], which also did not indicate a significant diffe-

rence between well and inadequately controlled diabetic patients.

Accordingly, a recent meta-analysis that examined studies using a 7% HbA1c cut-off level, as we did in our study, showed no statistical difference in DMFT between patients with good and inadequate metabolic control, as well [18].

However, subjects with poor metabolic control in our study had a significantly higher rate of extracted teeth. This is similar to the results of research conducted in Hungary which showed the number of filled teeth was higher in well-controlled than in patients with poorer glycemic control [30]. These findings may suggest a lower motivation for oral health care in these patients and/or sparse dental attendance.

When it comes to periodontal indices, in our study, poorly controlled diabetic patients had significantly higher PI and GI scores. Siudikiene et al. [35] also found higher GI values in poorly controlled subjects, but the differences were not statistically significant.

Another study assessing the correlation between periodontal disease and T1DM in adolescents found that the most periodontal alterations were present in young people with $\geqslant$ 9% HbA1c [36].

Although there is a large body of scientific evidence that diabetes is a major risk factor for periodontitis, studies comparing periodontal indices in young T1 DM patients with respect to glycemic control are sparse.

In a recent Systematic review [37] authors were unable to assess the relationship between glycemic control and periodontal risk markers in children with T1DM due to heterogeneity of the studies.

However, DM has been shown to increase the risk of developing periodontal disease almost threefold compared to healthy individuals, and the risk is higher if glycemic control is poor [38]. Hyperglycemia increases the concentration of glucose in saliva and gingival crevicular fluid, promoting the proliferation of pathogenic bacteria and increases oral inflammation. Besides, the presence of elevated levels of proinflammatory mediators in the crevicular fluid of poorly controlled diabetics also leads to increased periodontal destruction. [39] In a study of experimental gingivitis, after subjects refrained from oral hygiene for 21 days, there was no difference in PI levels between type 1 diabetics and healthy controls, but diabetics developed gingivitis earlier and in a more severe form than healthy patients. [40]

In addition to the aforementioned biological factors, less favorable periodontal parameters in patients with poor metabolic control are likely to be related to behavioral factors and their overall health behavior and practices. Namely, studies examining the oral hygiene habits of insulin-dependent patients have shown that those with regular and adequate oral hygiene habits are more likely to have lower levels of HbA1c [41, 42].

Conclusion

The results of the study showed that children with poorly controlled glycemia have significantly higher amounts of dental plaque as well as more severe gingival changes than children with well-controlled diabetes. This indicates the need for early screening of risk factors for the occurrence of periodontal disease in these patients, to prevent development of a progressive form of periodontal disease.

Although metabolic control has not been found to significantly affect caries rates, more frequent extractions in patients with uncontrolled glycemia indicate negative health behaviors and irregular dental attendance, both of which require correction through education and motivation to establish good oral health habits.

Conflict of interest

The authors declare no conflict of interest.

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