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ORAL HEALTH AND RISK FACTORS OF PERIODONTAL DISEASES IN YOUNG PEOPLE WITH TYPE 1 DIABETES MELLITUS

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The **aim** of the study was to assess the state of oral health in young people with type 1 diabetes and without systemic diseases, based on a comparative analysis, to determine the features of the course of periodontal diseases and risk factors for their development.

Material and methods. 63 patients aged 19–34 years with type 1 diabetes and without other systemic diseases were involved in the clinical study. A comprehensive clinical study was conducted on the main indicators of oral health.

Research results. Significant differences in periodontal status, including a higher prevalence of severe periodontitis, were found between young patients with type 1 diabetes and a healthy control group. Risk factors for the progression of periodontitis in patients with type 1 diabetes were identified.

Conclusion. A high prevalence of periodontitis has been found in patients with type 1 diabetes, which may be due to social, behavioral, hygienic, and metabolic risk factors.

Keywords: oral health, periodontitis, type 1 diabetes mellitus, young people, risk factors.

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ЗДОРОВ'Я РОТОВОЇ ПОРОЖНИНИ, ЧИННИКИ РИЗИКУ ХВОРОБ ПАРОДОНТА У МОЛОДИХ ОСІБ З ЦУКРОВИМ ДІАБЕТОМ 1 ТИПУ
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Проведено порівняльний аналіз стану здоров'я ротової порожнини у осіб молодого віку з цукровим діабетом 1 типу і без загальносоматичної патології з метою визначення особливостей перебігу хвороб пародонта та чинників ризику їх розвитку. Встановлено вірогідні відмінності в показниках індикаторів клінічного здоров'я ясен, прогресування запально-деструктивних процесів у тканинах пародонта у пацієнтів з цукровим діабетом 1 типу, що зумовлено соціальними, поведінковими, місцевими та метаболічними чинниками ризику.

Ключові слова: здоров'я ротової порожнини, періодонтит, цукровий діабет 1 типу, молоді особи, фактори ризику.

Introduction

Type 1 diabetes mellitus (T1DM) is a chronic immune-mediated endocrine disorder with both medical and social consequences. A growing trend in T1DM incidence has been recorded across Europe, posing a serious challenge to healthcare systems [1].

Periodontal diseases (PD) are highly prevalent globally and are characterized by the progression of inflammatory-destructive processes that, with age, lead to deterioration of the dentoalveolar structures and premature tooth loss [2].

Numerous clinical and experimental studies have investigated the bidirectional relationship between PD and T1DM and examined the shared aspects of their pathogenesis [3]. While both conditions share common pathobiological mechanisms of inflammation, the inflammatory response in T1DM is triggered by autoimmune dysfunction, whereas in periodontal tissues, it is primarily microbial in origin [4]. Alterations in immune-inflammatory responses and the distinct systemic and local pro-inflammatory reactivity to microbial pathogens may act as disease-modifying factors influencing the progression of gingivitis and periodontitis in individuals with T1DM.

Hyperglycemia, a systemic factor linked to insulin deficiency in T1DM, adversely affects salivary gland function, promotes dental plaque accumulation, and enhances the activity of pro-inflammatory mediator cascades in the gingival tissues, thereby contributing to PD development [5].

The duration of T1DM also has a detrimental effect on oral health. Advanced glycation end products (AGEs) can activate pro-inflammatory signaling pathways, disrupt microvascular circulation, and lead to chronic systemic complications. Hyperglycemia, as a metabolic factor, is recognized as a modifiable systemic risk factor for gingivitis [5].

A large body of evidence supports the negative impact of T1DM on periodontal health. The high prevalence,

increased susceptibility, and accelerated progression of periodontitis in people with T1DM have been confirmed in clinical trials [6], systematic reviews [4], and meta-analyses [7].

According to a consensus report on the periodontal manifestations of systemic diseases, diabetes is considered a key modifying factor in periodontitis and should be included in the clinical diagnosis of PD as a descriptor [8].

Recent European guidelines emphasize that glycemic control significantly influences the severity of periodontal disease [8].

Studying the development of PD in young individuals with T1DM and identifying its risk factors is essential for designing targeted preventive and therapeutic strategies aimed at maintaining gingival health and preventing pathological changes.

The **purpose** of the study was to conduct a comparative analysis of oral health status in young individuals with and without type 1 diabetes mellitus (T1DM), to identify the characteristics of periodontal disease progression, and to determine the associated risk factors in the T1DM group.

Materials and methods

A clinical multicenter, prospective, open, and controlled study was conducted to achieve the set goal.

The study included 63 patients aged 19–34 years, who were divided into groups with T1DM and a control group stratified by age [9]. The study groups consisted of 30 patients with T1DM, who were divided according to WHO recommendations (June 2024) into two age groups: Group ID included 14 patients with T1DM aged 19–24 years (mean age: M±SD: 22.5±2.4 years); Group IID included 16 patients with T1DM aged 25–34 years (mean age: M±SD: 30.6±5.1 years).

For the comparative analysis of oral health status, 33 somatically healthy patients were included, age-standardized and divided into two groups: Group IC – 15 patients (mean age: M±SD: 22.8±1.9 years), and Group IIC – 18 patients (mean age: M±SD: 29.9±3.2 years).

Dental examination was conducted according to standard methodology: evaluation of complaints, medical history using a questionnaire, and clinical oral examination. Diagnosis and assessment of patients with T1DM were carried out at the State Institution "V.P. Komisarenko Institute of Endocrinology and Metabolism of the National Academy of Medical Sciences of Ukraine" in accordance with medical and technological guidelines [10].

Based on the questionnaire, the following aspects were evaluated: professional oral care, frequency of dental visits for therapeutic and preventive purposes, treatment of gum inflammation by a periodontist, frequency of tooth brushing, use of dental floss, dietary habits, and consumption of sweets during snacks.

From medical records, the following metabolic characteristics of T1DM were identified: disease duration, glycemic control level (HbA1c, fasting glucose), and number of chronic complications, including retinopathy, angiopathy, neuropathy, and nephropathy [10].

The dental status of patients with T1DM was assessed at the clinical base of the Department of Therapeutic and Pediatric Dentistry of the Shupyk National Healthcare University of Ukraine. The condition of hard dental tissues was evaluated using the DMFT (Decayed, Missing, Filled Teeth) index.

Oral hygiene was assessed using the simplified oral hygiene index (OHI-S) by Green–Vermillion, Silness–Löe Plaque Index, the Stellard Plaque Index, and the Calculus Index [11].

The activity of inflammatory processes was evaluated using the papillary-marginal-alveolar index (PMA). Gingival inflammation and severity were assessed using the Gingival Index (GI). Overall periodontal status and treatment needs were determined using the Community Periodontal Index (CPI).

Periodontal condition and diagnosis were assessed according to clinical indicators of periodontal health, including bleeding on probing (BoP), probing pocket depth (PPD), clinical attachment level loss (CAL), gingival recession, tooth mobility, and radiographic findings, in accordance with the 2018 International Classification of Periodontal and Peri-Implant Diseases and Conditions [12; 13], as well as the Ukrainian National Classifier NK 025:2021 "Classifier of Diseases and Related Health Problems" [14].

Statistical analysis was performed using R version 3.6.3 for Windows (GNU General Public License). Both quantitative and qualitative (discrete) data were analyzed. The Shapiro–Wilk test was used to assess the normality of quantitative data distribution. Non-normally distributed data are presented as median and interquartile range (Me [IQR]). Differences between independent groups were assessed using the Mann–Whitney U test. Qualitative (discrete) data were presented as n (number or score) and percentage (%), and analyzed using Fisher's exact test for two independent groups. A p-value <0.05 was considered statistically significant. Rank correlation between two nonparametric variables was assessed using Spearman's method.

Ethical approval. The study was conducted in accordance with the principles of the Code of Ethics of a Scientist of Ukraine (2009), the Code of Ethics of a Physician of Ukraine (2009), and the Declaration of Helsinki of the World Medical Association (2024 revision). All participants provided written informed consent. The clinical study protocol "Stratification of risks, pathogenetic aspects of periodontal disease progression, and their prevention and treatment in adolescents and young adults with type 1 diabetes mellitus", state registration number 0122U201639, was approved by the Ethics Committee of the Shupyk National Healthcare University.

Results of study

Professional and individual oral health care in the study groups

The results of the survey showed no statistically significant differences in the average number of annual dental visits between the groups with T1DM and the control groups: the T1DM group had an average of 3.5 (ID) and 4.1 (IID) visits per year. In the control groups, the average number of dental visits per year was 3.1 (IC) and 4.3 (IIC). The main reason for visits among T1DM patients was acute toothache or treatment of dental complications such as caries. Only 2 (14.3%) patients in group ID and 4 (25.0%) in group IID

sought specialized periodontal care. Increased attention to the underlying diagnosis – T1DM – led to more frequent visits to the endocrinologist.

The survey also revealed that preventive professional oral hygiene was not a focus for patients with T1DM. They sought preventive dental services significantly less often. The rate of visits for professional oral hygiene in group ID was 0.33 and in group IID – 0.42 per year. Adult patients in control group IIC were more responsible regarding oral health: the number of professional oral hygiene visits was 0.93 per year compared to 0.54 in the IID group.

According to the questionnaire, awareness of the need for twice-daily brushing increases with age. In adult groups, 100% of patients in IID and IIC reported brushing their teeth twice a day. Among younger individuals, brushing once or less per day was noted in 5 (35.7%) patients from group ID and 2 (13.3%) from group IC.

Dental floss was more commonly used by patients in group IIC – 10 (55.6%), compared to 4 (25.0%) in group IID. Among younger individuals, only 3 (20.0%) from group IC and 2 (14.3%) from group ID used dental floss. These results reflect low awareness about the importance of cleaning proximal surfaces with floss in daily oral hygiene routines.

Features of eating habits in participants of the study groups

In the study groups, patients with T1DM were well-informed about the balanced intake of carbohydrates, proteins, fats, vitamins, and minerals, and about the negative impact of "fast" carbohydrates on blood glucose levels. As a result, they avoided sweets, cookies, carbonated drinks, and snacking between meals. In contrast, young and adult individuals without T1DM more often reported irregular eating patterns and frequent snacking on cookies, candies, sweets, and sugary drinks.

Medical characteristics of the study groups

A comparative analysis of the two study groups – young and adult – showed a significant increase in the duration of T1DM with age. An increase in the median glycated hemoglobin level (p=0.364) was also recorded with age, indicating the cumulative effect of T1DM (Table 1). The patients were treated at the SI "V.P. Komisarenko Institute of Endocrinology and Metabolism of the NAMS of Ukraine", where poorly controlled T1DM (>7.5%) was diagnosed.

According to the patients' medical records, the number of T1DM complications increased with age. More patients suffered from one or more chronic complications: in group ID, 5 (35.7%) had chronic complications (angiopathy, retinopathy, nephropathy, neuropathy), while in group IID – 9 (56.3%). The duration of T1DM, poor glycemic control, and complications had a negative impact on oral health.

Assessment of dentition status in the study groups

A comparative analysis of caries intensity was conducted among young and adult individuals with type 1 diabetes mellitus (T1DM) and those without systemic diseases (Table 2).

Significant differences in DMFT scores were found both among young and adult participants. A tendency for an increase in caries intensity with age and duration of T1DM was observed. According to WHO recommendations, such DMFT values indicate a high level of caries experience (DMFT>7).

The negative cumulative effect of T1DM, its duration, and chronic complications is evidenced by the number of teeth extracted: in young people, this indicator was 4.9±2.23 teeth, while in adults it was significantly higher at 6.5±3.43 teeth. The loss of a substantial number of teeth adversely affects periodontal tissues, which may lead to deformation of dental arches, occlusal instability, and functional overload of the remaining teeth. All these factors exacerbate the severity of periodontitis and accelerate further tooth loss.

Clinical assessment of oral hygiene in the study groups

Clinical indices were used to assess the oral hygiene status. Higher values of the Simplified Oral Hygiene Index (OHI-S) by Green–Vermillion were recorded in the groups with T1DM compared to the control groups (Table 3).

This research revealed an increasing trend in the OHI-S index with age, with significant differences observed in the adult group. In contrast, the comparative analysis of the control groups showed an opposite trend: adults demon-

Table 1

Medical characteristics of patients from the examination groups

	ID, M±SD n=14	IC, M±SD n=15	p-value	IID, M±SD n=16	IC, M±SD n=18	p-value
Age	22.5±2.4	22.8±1.9	p>0.05	30.6±5.1	29.9±+3.2	p>0.05
Duration	7.1±3.4	not observed		9.6±4.3	not observed	
Glycosylated hemoglobin HbA1c (%)	9.9±3.5	3.38±1.14	p<0.05	11.7±3.6	3.35±1.09	p<0.05
Chronic complications, number of patients	5 (35.7%)	not observed		9 (56.3%)	not observed	

Table 2

The intensity of caries according to the DMFT index was assessed in the study groups

	ID, M±SD n=14	IC, M±SD n=15	p-value	IID, M±SD n=16	IIC, M±SD n=18	p-value
DMFT index, teeth	12.11±2.32	10.32±1.73	p<0.05	12.94±2.66	10.43±1.91	p<0.05
Number of extracted teeth	4.93±2.23	2.41±1.64	p<0.05	6.52±3.43	2.18±1.32	p<0.05

Table 3

Indicators of oral hygiene in the study groups

	ID, Me±SD, n=14	IC, Me±SD, n=15	p-value	IID, Me±SD, n=16	IIC, Me±SD, n=18	p-value
OHI-S, scores	1.99±0.51	1.78±0.64	p>0.05	2.08±0.32	1.67±0.41	p<0.05
Silness–Löe Plaque Index, scores	1.87±0.65	1.18±0.32	p<0.05	1.91±0.57	1.14±0.29	p<0.05
Stallard Plaque Index, scores	2.12±0.67	1.33±0.28	p<0.05	2.34±0.65	1.21±0.21	p<0.05
Calculus Index, scores	1.96±1.12	1.28±0.09	p<0.05	2.12±1.23	1.28±0.11	p<0.05

strated more responsible personal oral hygiene and visited the dentist more regularly for preventive care.

Significant differences in the Silness–Löe Plaque Index were found between the T1DM groups and controls ($p<0.05$), indicating a higher rate of dental plaque accumulation in patients with T1DM. Moreover, a tendency toward worsening oral hygiene according to the Silness–Löe Plaque Index with age was observed in patients with T1DM, whereas no significant age-related changes occurred in the control groups.

Poor oral hygiene, increased plaque accumulation, and significant differences in the Stellard Plaque Index between the T1DM groups and systemically healthy controls contribute to the gradual formation of dental calculus. The Calculus Index was significantly higher ($p<0.05$) in patients with T1DM compared to controls.

Clinical assessment of periodontal status in the study groups

The activity of inflammatory processes in periodontal tissues was assessed using the PMA Index. Significant differences in PMA values were found between patients with T1DM and somatically healthy individuals. Inflammatory processes in periodontal tissues tended to worsen with age in the T1DM groups; however, no significant age-related differences were observed in the control groups ($p>0.05$). Significant differences ($p<0.05$) were also registered in the gingival index between patients with T1DM and the age-matched control groups (Table 4).

Active inflammatory processes in periodontal tissues lead to increased gingival bleeding: significantly higher BoP index values ($p<0.05$) were found in patients with T1DM (ID: 1.26±0.43 points; IID: 1.91±0.67 points) compared to control groups of young patients (IC: 1.09±0.18 points) and adults (IIC: 1.03±0.08 points).

According to WHO recommendations, the Community Periodontal Index (CPI) was used to assess periodontal tissue status and treatment needs by evaluating gingival bleeding, presence of calculus, and periodontal pocket depth in six sextants of the oral cavity. Significantly higher CPI values were registered in the study groups: (ID: 2.45±0.84 points; IID: 3.01±0.89 points) compared to controls (IC: 1.38±0.32 points; IIC: 1.22±0.28 points) ($p<0.01$). Elevated CPI scores in young patients indicate a need for periodontal treatment.

Progression of PD in patients with T1DM is evidenced by increased periodontal pocket depth (PPD) and clinical attachment loss (CAL). Significantly higher PPD values ($p<0.01$) were recorded in T1DM patients (ID: 4.3±1.45 mm; IID: 5.1±1.98 mm) compared to controls. CAL values were also higher in the study groups.

A trend toward worsening PPD and CAL with age was observed and was closely linked to poor glycemic control. These findings indicate a disease-modifying effect of T1DM on periodontal tissues.

Active inflammatory processes and symptomatic gingival hypertrophy lead to increased gingival margin level, thus average gingival recession was greater in control groups than in the study groups.

Clinical signs of periodontitis were observed in 12 (85.7%) young patients in the ID group and 16 (100%) adults in the IID group with T1DM. Among young patients in ID group, 2 (14.3%) had moderate chronic gingivitis, 7 (50.0%) stage I periodontitis, 4 (28.6%) stage II periodontitis, and 1 (7.1%) patient stage III periodontitis. In adults

Table 4

Comparative analysis of the main indicators of periodontal tissue health in the study groups

Indicators	ID, Me±SD, n=14	IC, Me±SD, n=15	p-value	IID, Me±SD, n=16	IIC, Me±SD, n=18	p-value
PMA, %	36.54±4.31	26.17±2.65	p<0.01	39.87±5.31	24.21±2.43	p<0.01
Bleeding on probing, points	1.26±0.43	1.09±0.18	p<0.05	1.91±0.67	1.03±0.08	p<0.01
Gingivitis index, points	1.87±0.87	1.23±0.22	p<0.05	1.98±0.76	1.17±0.31	p<0.01
Community periodontal index (CPI), points	2.45±0.84	1.38±0.32	p<0.01	3.01±0.89	1.22±.0.28	p<0.01
Probing pocket depth, мм	4.3±1.45	2.6±0.89	p<0.01	5.1±1.98	2.1±0.45	p<0.01
Clinical attachment level loss, мм	2.34±1.45	1.58±0.32	p<0.01	3.22±1.88	1.61±0.53	p<0.01
Gingival recession, мм	0.09±0.12	0.17±0.15	p>0.05	0.21±0.19	0.29±0.18	p>0.05

from IID, periodontitis was detected in 100% of cases: 6 (37.5%) with stage I periodontitis, 8 (50.0%) with stage II periodontitis, and 2 (12.5%) with stage III periodontitis.

In the control groups, periodontal diseases were found in 9 (60.0%) young people and 10 (55.5%) adults. Gingivitis of varying severity was predominant: 8 (53.3%) young and 6 (33.3%) adults, mainly due to inadequate oral hygiene. Stage I periodontitis was registered in 1 (6.67%) young patient and 4 (22.2%) adults.

Determination of risk factors for the development of periodontal diseases

The Spearman rank correlation method was used to evaluate the relationship between risk factors and the development of caries and gingivitis.

Inflammatory processes in periodontal tissues (PMA index) were correlated with poor oral hygiene according to the Silness–Löe Plaque Index (r_s=0.71, p<0.01), and showed a strong correlation with the presence of dental calculus (r_s=0.76, p<0.01).

The bleeding on probing (BoP) index in young individuals with T1DM was closely associated with the Silness–Löe Plaque Index (r_s=0.63, p<0.01), the degree of plaque accumulation on teeth according to the Stellard Index (r_s=0.59, p<0.01), and the presence of dental calculus (r_s=0.79, p<0.01).

The progression of periodontitis was strongly associated with the duration of T1DM, indicating a disease-modifying effect of T1DM on periodontal health. A strong correlation was found between periodontal pocket depth (PPD) (r_s=0.72, p<0.01) and clinical attachment level loss (CAL) (r_s=0.74, p<0.01) with the duration of T1DM.

Discussion

The disease-modifying effect of type 1 diabetes mellitus (T1DM) on the salivary glands and the elevated glucose levels in saliva contribute to changes in dental plaque accumulation, which may negatively affect both the remineralization of dental hard tissues and the inflammatory response in the gingiva.

According to a meta-analysis, patients with T1DM showed a significantly higher level of dental plaque accumulation (MD: 0.47, 95% CI [0.06, 0.89]) compared to somatically healthy individuals. However, the gingival index did not show a statistically significant difference between the groups [15].

Current periodontology increasingly focuses on the infectious and inflammatory processes in periodontal tissues. As there is no conclusive evidence regarding alterations in the subgingival microbiota in patients with T1DM, current research is concentrated on understanding the pathobiological mechanisms of inflammation. Given that chronic inflammation is closely linked to autoimmune disorders involved in the development of T1DM, the exploration of shared inflammatory pathways is a relevant and promising area of research.

The present study demonstrated higher levels of inflammatory markers and a greater progression of periodontal disease, specifically periodontitis, with increasing age in patients with T1DM.

A systematic review involving 5,888 patients with T1DM found that the prevalence of periodontitis in this population was 18.5% (95% CI=8.0–37.1), which is significantly higher than in the general population. The meta-analysis confirmed that the prevalence of periodontitis in patients with T1DM is approximately twice that of individuals without diabetes.

Moreover, patients with T1DM had significantly greater periodontal pocket depth (PPD), with a mean of 2.51 mm (95% CI=1.32–4.76; p=0.005), and greater clinical attachment level loss (CAL), with a mean of 0.506 mm (95% CI=0.181–0.832; p<0.005), compared to the control group [16].

The high prevalence of periodontal diseases in individuals with T1DM suggests a significantly increased risk for the progression and severity of periodontitis. Chronic hyperglycemia negatively affects the osteogenic potential of bone tissue cells, causes structural changes in osteoblasts [17], which leads to a decrease in the mineral density of the lower jaw [18] and progression of alveolar bone resorption.

Gingivitis is a major risk factor and a necessary precursor to periodontitis. Therefore, managing gingivitis remains the key strategy in the prevention of periodontitis [19].

Conclusions

1. A high prevalence of periodontal diseases was found among patients with T1DM, including all 14 (100%) young individuals in group ID and 16 (100%) adults in group IID with T1DM, compared to patients without systemic diseases (9 (60.0%) young individuals and 10 (55.5%) adults).

2. In the structure of periodontal diseases among individuals with T1DM, periodontitis predominated – 85.7% in young individuals and 100% in adults (with various stages of severity), compared with 1 (6.67%) young and 4 (22.2%) adults in the control group. In the control group, gingivitis was more common – observed in 8 (53.3%) young and 6 (33.3%) adults.

3. Rapid progression of periodontal diseases was identified in patients with T1DM: a significant increase in PPD and clinical attachment level loss (p<0.05) compared to the control groups. A strong correlation was registered between the duration of T1DM and both probing pocket depth (PPD) (r_s=0.72, p<0.01) and clinical attachment level loss (r_s=0.74, p<0.01), indicating a disease-modifying effect of T1DM on periodontal health.

4. Social factors included low patient awareness regarding the need for preventive and therapeutic periodontal care. Behavioral factors included inadequate personal oral hygiene. Local factors – premature tooth loss, poor oral hygiene, active inflammatory periodontal processes. Disease-modifying factors – duration of T1DM, uncontrolled hyperglycemia. All these negatively impact periodontal health and must be taken into account in the treatment and prevention of periodontal disease in patients with T1DM.

Perspectives. The conducted study demonstrated significant differences in the clinical indicators of oral health. A study of skeletal bone tissue metabolism is planned in order to assess its impact on the condition of periodontal tissues and the progression of periodontitis. The future study will use factor analysis to determine the disease-modifying influence of diabetes mellitus on periodontal health.

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