

DIABETES MELLITUS AND ITS IMPACT ON THE STATE OF THE ORAL CAVITY IN CHILDREN*

A. I. Maksymenko, O. V. Sheshukova, T. V. Polishchuk,
V. P. Trufanova, K. S. Kazakova, S. S. Bauman, O. A. Pysarenko

Poltava State Medical University, Poltava, Ukraine
a.maksymenko@pdmu.edu.ua

Diseases of the endocrine glands among the population of children attract the special attention of scientists and clinicians. This is because at present, the endocrinological morbidity of children and adolescents in Ukraine consistently occupies one of the leading places in the structure of all diseases [1-3].

In our country, there is an increase in the number of patients with various endocrinopathies, but the most common among them are diabetes mellitus (DM) and thyroid diseases. They account for more than 80% of all endocrine pathology. Diabetes mellitus is one of the most serious diseases in terms of its course and complications. The analysis of statistical data is discouraging, showing that the prevalence of this disease is increasing. This is, to some extent, due to the poor quality of preventive examinations of children and the insufficient detection of endocrine pathology by primary care doctors [4, 5].

Studies of national and foreign scientists have consistently shown that the body is an integral system and any disorders of the endocrine system are accompanied by changes in various organs and systems, including the dentition. For the first time, the connection between DM and changes in the oral cavity was established by Seifert in 1862 [6, 7]. Therefore, at the moment, more and more attention of researchers and practicing dentists are being attracted to the peculiarities of the development of dental diseases in children suffering from endocrinopathies [8, 9].

It is known that DM disrupts all types of metabolism, causes changes in cellular and humoral immunity, and is characterized by persistent haemorrhage (increased blood viscosity, aggregation capacity of erythrocytes and platelets, fibrinolytic activity of plasma, decreased blood flow), neuroregulatory disorders, and slowing of regenerative and reparative pro-

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cesses. The development of DM complications is associated with hyperglycaemia and pathological changes in blood vessels and the peripheral nervous system. Therefore, an individually chosen treatment regimen, following the recommendations of an endocrinologist, and maintaining a diet contribute to the long-term compensation of DM and slow the progression of diabetic complications [10, 11].

The negative impact of DM on oral tissues is carried out through the following mechanisms:

- increased activity of matrix metalloproteinases (collagenases);
- increased glucose content in the oral fluid, which leads to dysfunction of the cells of the mucous membrane and periodontal tissues, decalcification of teeth, and, accordingly, tooth decay and affects the microbiocenosis of the oral cavity;
- vascular changes;
- disruption of the immune response, resulting in a weakening of neutrophil function and a hyperreactive monocytic response, which leads to the destruction of oral tissues;
- glucose binding to tissue proteins [3, 12–14].

A persistent increase in blood glucose concentration is accompanied by the accumulation of glycated haemoglobin, which negatively affects the condition of many organs and tissues, causing the development of severe complications such as diabetic nephropathy, angiopathy, neuropathy, ophthalmopathy, micro- and macroangiopathy. Children with DM have a reduced immune system response and severe infectious diseases. And almost all patients with diabetes have dental pathology [14, 15].

The most severely affected are those organs of the oral cavity in which the vessels carry the maximum functional load. First of all, these are periodontal tissues, although other dental pathologies, such as caries, and inflammatory and infectious diseases of the oral mucosa and salivary glands, are more common in diabetic patients than in children without somatic pathology [16–18].

The first and most frequent symptoms in patients with DM are dry mouth (xerostomia) and dry lips due to dehydration in the setting

of polyuria, which is especially pronounced in children with decompensated diabetes [11].

Dry mouth in children with DM is accompanied by increased thirst and appetite. The mucous membrane is shiny, and hyperaemic, and catarrhal inflammation covers almost the entire oral mucosa [14, 19].

The composition and properties of the oral fluid in children with DM differ significantly from those of somatically healthy individuals by all indicators. Especially it concerns enzymatic activity. Almost always there is a disruption of the acid-base balance with a shift towards acidosis [20, 21].

One of the most significant signs of changes in the oral fluid is also an increase in glucose level by almost an increase in comparison with healthy individuals. There is a direct correlation between the glucose level in the oral fluid and in the blood [22].

Changes in the oral fluid lead to a disruption of its main functions, namely, mineralizing, cleansing, and protective, and the prevalence of demineralization over remineralization, which leads to the development of dental caries [23].

Based on literature data, the etiological factors of caries in children with type 1 DM are physicochemical changes in the properties of oral fluid, increased levels of cariesogenic bacteria, which depends on the degree of compensation of the disease, as well as structural and functional features of dental tissues (determined by the composition and structure of enamel and other hard tissues of the teeth, the level of enamel permeability, and the functional state of the pulp), deterioration of self-cleaning of the tooth surface, rapid formation of dental plaque in compliance with the regime of oral hygiene, quantitative and qualitative changes in the composition of the oral microflora [22, 24–26].

The rapid formation of dental plaque in patients with DM is due to increased levels of glucose in the oral and gingival fluid, and changes in the pH of the oral fluid. The high concentration of glucose in saliva (from 0.44 to 6.33 mg of glucose per 100 mL of saliva, with a normal range of 0.24 to 3.33 mg) promotes rapid bacterial growth and tartar formation. In the presence of metabolic acidosis, an increase in the

ammonia-producing activity of urease-positive plaque microflora is detected [21, 23, 27].

Some children with DM have increased sensitivity to the necks of their teeth. A study of the initial sensory thresholds in diabetic patients showed that the values of these thresholds correlate with blood glucose levels. A decrease in blood glucose is accompanied by a significant decrease in pain sensitivity and an increase in blood glucose is accompanied by an increase in pain sensitivity. After dental intervention, 60% of patients with DM have decreased sensory thresholds [14, 20].

A special place among the manifestations of diabetes in the oral cavity in children is held by inflammatory and inflammatory-dystrophic periodontal diseases.

Periodontal tissue inflammation in children with DM has a complex genesis. Angiopathy is the most important factor in the development of periodontal tissue inflammation in diabetic patients. The starting point of diabetic microangiopathies is a disorder of carbohydrate metabolism, as well as a disorder of glucosamine metabolism, which determines the functional and structural integrity of the basal membrane of blood vessels. Vascular changes in DM are peculiar: the lumen of the vessel, as a rule, does not completely close, but the vessel wall is always affected [28, 29].

According to the results of studies, the risk of periodontitis in children with DM is 2.5–3.5 times higher than in people with an uncomplicated anamnesis. The following changes are pathogenetically significant for periodontal tissue diseases and diabetes: angiopathy, primarily at the level of microcirculatory vessels; metabolic disorders, lipid peroxidation, tropism; osteoporosis and osteolysis; impaired colonization resistance; secondary immunodeficiency and autoaggression. In children with insulin-dependent DM, in addition to xerostomia and hyposalivation, the progression of inflammatory changes in periodontal tissues is detected, and the intensity and rate of plaque formation increases. Significant progression of inflammatory phenomena in periodontal tissues and the risk of activation of secondary microbial and fungal infection are observed during various changes in blood glucose levels. During the development of the inflamma-

tory process in the periodontium in children, obligate anaerobic microflora represented by *Porphyromonas gingivalis*, *Prevotella melaninogenica*, *Streptococcus intermedius* is detected; the number of *Candida albicans* fungi increases, while the number of diphtheroids and lactobacilli decreases, which is a prognostic factor in gingivitis [2, 30, 31].

Microangiopathies in DM lead to increased resorptive processes in bone tissue, and thickening of the basal microvascular membrane impedes the intake of trace elements and oxygen diffusion into periodontal tissues, which, in addition to existing metabolic disorders, inhibits reparative processes in alveolar bone and mucosa [20, 29].

Particularly interesting are the data on pathological changes in bone tissue in DM, and the relationship between hyperglycaemia and atrophy of the alveolar part. It is noted that insulin insufficiency reduces the activity of osteoblasts, the synthesis of collagen, and enzymes necessary for bone formation. Insulin deficiency also increases the activity of osteoclasts, which increase bone resorption. At the same time, children with diabetes have impaired intestinal calcium absorption, and increased secretion of parathyroid hormone, which leads to a decrease in osteocalcin levels and further promotes bone resorption. Microangiopathy results in impaired bone nutrition [10, 13].

It is well known that patients with DM develop osteoporosis and reduce the ability to regenerate bone tissue much earlier than in people without carbohydrate metabolism pathology [2, 10].

According to many authors, a typical feature of periodontal disease in children with DM at radiological examination is bone damage in the clinically intact periodontium, characterized by destructive processes in the bone of the alveolar part, osteoporosis of the apices of the interdental septa, which indicates a frequent discrepancy between clinical and radiological data [29–30].

In adolescents with generalized periodontitis in DM, an imbalance of bone remodelling processes is detected; increased bone resorption (high excretion of calcium and inorganic phosphorus in the urine, increased oxyproline in the urine) with some decrease in bone forma-

tion, decreased osteocalcin levels in the blood serum [13, 28].

The data of the investigators showed that in children with inflammatory and dystrophic processes in periodontal tissues in DM, atherogenic plasma lipid disorders were detected, which were considered as a risk factor for microcirculatory disorders in the periodontium [15, 20].

To the present day, a relationship between DM and candidiasis has been identified. New environmental factors, lifestyle, and microbial variability create more and more conditions for a significant predisposition of diabetic patients to mycoses [14, 18].

Candida yeast-like fungi are representatives of the normal microbiota of the human body, including the oral cavity biotope. High concentrations of glucose in the blood and oral fluid, xerostomia, and suppression of the protective properties of the salivary secretion are the basis for the acquisition of pathogenic properties by Candida fungi and facilitate their adhesion, colonization, and invasion of the oral mucosa [20, 32].

The clinical features of candidiasis in the setting of pancreatic dysfunction are directly related to the severity and nature of their course, the severity of diabetes, and the effectiveness of treatment [11, 16, 18].

The pathogenetic parallels of oral mucosal candidiasis in DM are due to the following factors: disorders of various types of metabolism cause an imbalance in the synthesis of macroergic compounds, resulting in changes in the synthesis of antibodies, decreased phagocytic activity of leukocytes and macrophages, decreased tissue permeability, weakened compensatory reactions of the body, and barrier functions of the skin and mucous membranes [33].

In the oral cavity with candidiasis, the mucosa of the lips, cheeks, tongue, and palate is dry, thinned, and bright red, with white foci that form soft lesions. Removal of the layers reveals an easily bleeding surface with congestive hyperaemia and atrophy of the filiform papillae [34, 35].

In angular cheilitis (mycotic lichen planus), there is a thinning of the red border of the lips and intense hyperaemia of the Klein zone, and infiltrated, long-standing defects are formed in the corners of the mouth [36].

Diabetic mycoses are characterized by an exceptionally long course and a tendency to deep tissue damage – with the formation of ulcers, without inflammatory infiltrates, with flaccid granulations, enlarged regional lymph nodes, sometimes abscessing infiltrates and gangrenous decay is possible [37, 38].

Children with DM are often diagnosed with chronic recurrent aphthous stomatitis (CRAS). The pathogenesis of CRAS is dominated by disorders of the regulatory function of T lymphocytes, which lead to the coordination of helper and suppressor activity. As a result, the structural and functional resistance of the oral mucosa decreases. Recurrence in most patients occurs 1–2 times a year and quite often coincides with a decompensation of DM [14, 39].

One of the manifestations of DM in the oral cavity is the appearance of leukoplakia. Initially, large matte areas of cornification of the oral cavity appear. Later, plaques are formed, which progress rapidly, and warty growths, cracks, and ulcers are observed in the setting of constant hyposalivation [8, 15].

In most children with insulin-dependent DM, the tongue is covered with white plaque, rough, and swollen, with areas of epithelial desquamation in the form of a geographical map, red-purple in colour, as well as atrophy of the filiform and hypertrophy of the mushroom papillae [35, 38].

It should be noted that the presence of diabetes in dental patients complicates all types of interventions in the oral cavity due to damage to the microvascular system, bone resorption, progressive atrophy of the alveolar bone (a part of it), a decrease in local immune responses, increased pain sensitivity of the oral mucosa, which leads to a decrease in periodontal endurance [8, 11, 16].

CONCLUSION

Thus, the analysis of scientific papers shows the presence of significant pathological changes in the oral cavity in children with

diabetes mellitus, which are related to the dynamics of the disease and aggravate its course. Therefore, the planning of dental treatment of

patients with diabetes at each clinical stage should be based on a clear understanding of all pathogenetic chains, manifestations of various forms of diabetes in the oral cavity, and the relationship with the state of carbohydrate metabolism compensation. It is these difficult chains of the pathogenesis of the inflammatory reaction in the oral mucosa and periodontal tissues in the setting of diabetes mellitus that are still not well studied. Knowledge of the dental manifestations of diabetes mellitus will help

a paediatrician diagnose the disease in a child at the preclinical level. Interdisciplinary interaction between paediatricians, endocrinologists, and paediatric dentists will allow us to reveal in more detail the common causes and mechanisms of the pathogenesis of periodontal and oral mucosa diseases in children with insulin-dependent diabetes mellitus, which will further allow us to substantiate an integrated approach to the diagnosis, treatment, and prevention of major dental diseases in children.

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V. P. Trufanova, K. S. Kazakova, S. S. Bauman, O. A. Pysarenko

Poltava State Medical University, Poltava, Ukraine
a.maksymenko@pdmu.edu.ua

Today, the number of people with diabetes is growing in all age groups both in our country and around the world. Diabetes is one of the most serious diseases in terms of its course and complications. It is known that diabetes destroys all types of metabolism, changes cellular and humoral immunity, is characterized by persistent haemorrhagic and neuromodulatory disorders, and slows down regenerative and reparative processes. The development of diabetic complications is associated with hyperglycaemia and is accompanied by pathological changes in blood vessels and the peripheral nervous system.

Studies by Ukrainian and foreign scientists have repeatedly shown that the body is an integral system and that endocrine disorders are accompanied by changes in various organs and systems, including the dentition. Although periodontal tissues are the main affected organ, other dental lesions, such as caries, inflammatory and infectious diseases of the oral mucosa and salivary glands. They are more common in diabetic patients than in children without somatic lesions. The first and most common symptoms in diabetic patients are dry mouth (xerostomia) and dry lips due to dehydration with polyuria, which is especially noticeable in children with worsening diabetes. Inflammatory periodontal diseases and inflammatory-dystrophic periodontal diseases occupy a special place among the symptoms of diabetes in the oral cavity in diabetic children. Vascular damage is of prime importance in the development of periodontal tissue inflammation in diabetic patients. Microangiopathy in diabetes mellitus enhances the process of bone resorption.

The analysis of scientific material shows that there are significant pathological changes in the oral cavity of children with diabetes mellitus, which are related to the dynamics of the disease and worsen its course.

Therefore, the planning of dental treatment of patients with diabetes at each clinical stage should be based on a clear understanding of all etiological relationships, manifestations of various forms of diabetes in the oral cavity and their relationship with the corrected state of carbohydrate metabolism.

A literature search was conducted using the databases Web of Science, Scopus, The Cochrane Library, MedLine, EMBASE and Global Health.

Keywords: diabetes mellitus, children, gingivitis, periodontitis, caries, candidiasis, review.

ЦУКРОВИЙ ДІАБЕТ ТА ЙОГО ВПЛИВ НА СТАН ПОРОЖНИНИ РОТА У ДІТЕЙ

Максименко А. І., Шешукова О. В., Поліщук Т. В.,
Труфанова В. П., Казакова К. С., Бауман С. С., Писаренко О. А.
Полтавський державний медичний університет, м. Полтава, Україна

a.maksymenko@pdmu.edu.ua

На сьогоднішній день спостерігається збільшення кількості хворих на цукровий діабет в усіх вікових категоріях населення нашої країни та світу. Цукровий діабет — одне з найтяжчих захворювань з точки зору перебігу та ускладнень. Відомо, що діабет руйнує всі види обміну речовин, змінює клітинний і гуморальний імунітет, характеризується стійкими геморагічними і нейромодуляторними порушеннями, уповільнює регенеративні та репаративні процеси. Розвиток діабетичних ускладнень пов'язаний з гіперглікемією та супроводжується патологічними змінами в судинах і периферичній нервовій системі.

Дослідження вітчизняних і зарубіжних вчених неодноразово показували, що організм — це цілісна система. Ендокринні порушення супроводжуються змінами в різних органах і системах організму маленького пацієнта, в тому числі і в зубощелепній. Тканини пародонту є основною мішенню, що вражається. Хоча, карієс та запальні й інфекційні захворювання слизової оболонки порожнини рота і слинних залоз, також частіше зустрічаються у дітей, хворих на діабет, ніж у осіб без соматичної патології. Першими і найпоширенішими симптомами у хворих на діабет є сухість у роті (ксеростомія) і сухість губ внаслідок зневоднення та поліурії, що особливо помітно у дітей з тяжкою формою перебігу діабету. Запальні та запально-дистрофічні захворювання пародонту займають особливе місце серед симптомів діабету в порожнині рота у дітей, хворих на цукровий діабет. Судинне ураження має першорядне значення в розвитку запалення тканин пародонта у хворих на діабет. Мікроангіопатія при цукровому діабеті сприяє пришвидженню процесу резорбції кісткової тканини.

Аналіз наукового матеріалу свідчить, що в порожнині рота дітей, хворих на цукровий діабет, існують значні патологічні зміни, які пов'язані з динамікою захворювання та погіршують його перебіг.

Тому планування стоматологічного лікування хворих на цукровий діабет на кожному клінічному етапі має базуватися на чіткому розумінні всіх етіологічних взаємозв'язків, проявів різних форм діабету в порожнині рота та їх взаємозв'язку із станом компенсації вуглеводного обміну.

Проведено літературний пошук з використанням баз даних Web of Science, Scopus, The Cochrane Library, MedLine, EMBASE та Global Health.

Ключові слова: цукровий діабет, діти, гінгівіт, пародонтит, карієс, кандидоз, огляд.