



Changes in the Biophysical Characteristics of Oral Fluid in Children with Type 1 Diabetes

1. Maxsumova S. S.
2. Maxsumova I. Sh.
3. Mukhamedova M. S.
4. Rakhmatullayeva D. U.
5. Khamidov I. S

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^{1,2,3,4,5} Tashkent State Dental Institute

Abstract: The article found that studies have identified biophysical aspects of oral fluid for children with type 1 diabetes, including changes in the rate of salivation rate, salivation volume, viscosity and pH. A significant increase in glucose levels disrupts the mineralization potential of solid tissues and mineralization processes, accelerates demineralization processes, increases the activity of microbial flora in the oral cavity, and leads to a violation of the balance of enzyme systems. In the later stages of endocrinopathy, a significant change in the pH level of oral fluid to acidosis indicates a weakening of buffer systems, a lack of functional capabilities and protective mechanisms of speech, and a disbalance in homeostatic reactions in the oral cavity.

Key words: diabetes mellitus, mouth fluid, composition, viscosity, speed of salivation.

Results of epidemiological studies conducted The International Diabetes Federation (IDF) in more than a hundred countries of the world indicates that type 1 diabetes mellitus (diabetes mellitus) ranks first among the endocrine pathology in the pediatric population, with a tendency to a steady increase in morbidity [1, 2,5].

Pathological processes that occur in the pancreas in type 1 diabetes in children are more or less reflected in all tissues of the body, but the earliest and most clearly expressed disorders are determined on the oral mucosa [3,6].

The presence of a close relationship between the oral cavity and various organs and systems of the body has been established by numerous studies and an in-depth study of this problem occupies an important place in dentistry [4,7].

Experts have proven that oral fluid, as a strictly structured system with certain properties and constancy of composition, due to the ability to remineralize the hard tissues of the teeth, neutralize acids, and reduce the activity of microflora, plays a key role in the regulation of oral homeostasis [8,10]. Oral fluid, as a connecting element between the macroorganism and the organs of the oral cavity, on the one hand, reflects the changes occurring at the tissue (organ) level, on the other hand, it has a direct impact on them by modifying physicochemical parameters, biological properties, and structural indicators [9,11].

The purpose of the study. Study of the biophysical properties of oral fluid in children with type 1 diabetes mellitus.

Materials and methods: In the course of the work, a dental examination was carried out for 72 children and adolescents suffering from type 1 diabetes at the age of 7-15 years (boys-33, girls-39), who were treated at the Republican Specialized Scientific and Practical Medical Center of Endocrinology. All patients were divided into 2 groups: control and patients with type 1 diabetes. The clinical study included the identification of patient complaints, anamnesis, visual inspection. To study the biophysical parameters of oral fluid from patients, samples of unstimulated saliva were taken in the morning on an empty stomach in sterile test tubes. The experience of endocrine pathology in patients with type 1 diabetes ranged from five months to ten years. The study included patients diagnosed with type 1 diabetes, who, depending on the experience of endocrinopathy, were divided into trigroups. The first group consisted of 25 children diagnosed with type 1 diabetes with up to one year of disease experience. The second group included 24 children with a duration of type 1 diabetes from one to five years. The third group included 23 children suffering from type 1 diabetes from six to ten years old.

The comparison group consisted of 37 (20 boys, 17 girls) practically healthy children (I-II health group, united in a single group (Y.E. Veltishchev, 1994)) of this age category with intact teeth.

In the course of the study, the rate of salivation, the daily excretion of unstimulated oral fluid, viscosity according to the method of T.L. Redinova, the level of gradation (ductility test) according to the method of P.A. Leus and the pH level of the oral fluid were determined.

Results and training. The results of the study of biophysical parameters of unstimulated oral fluid in children with type 1 diabetes indicate a multidirectional dynamics of changes in values with an increase in the duration of endocrinopathy: an increase in viscosity with a decrease in viscosity, the rate of salivation, combined with a shift in the pH level towards acidosis (see table).

Biophysical parameters of oral fluid in children with type 1 diabetes.

Options. Units Measurements	Research Groups			
	Comparison group (n=37)	First group (n=25)	Second group (n=24)	Third group n=23)
Salivation rate, (ml/min)	0,57±0,09	0,49±0,03	0,38±0,08	0,32±0,05
Daily excretion, (ml)	820,8±31,7	705,6±24,8	547,2±30,1	460,8±25,1
Viscosity, (units)	2,54±0,17	2,81±0,16	3,51±0,13	4,57±0,24
Viscousness, (units)	3,26±0,19	3,05±0,11	2,66±0,12	2,09±0,04
pH level, (units)	7,02±0,13	6,77±0,05	6,51±0,14	6,34±0,09

In children with endocrinopathy experience of up to a year, in comparison with healthy children, there is a slight decrease in the rate of salivation ($14.0 \pm 0.6\%$ - $15.8 \pm 0.9\%$), ductility ($5.8 \pm 0.3\%$ - $6.4 \pm 0.5\%$), increased viscosity ($10.6 \pm 0.4\%$ - $11.4 \pm 0.7\%$). An insignificant shift in the pH level of the oral fluid towards acidosis ($3.3 \pm 0.1\%$ - $3.6 \pm 0.2\%$) in the early stages of type 1 diabetes proves the effective operation of buffer systems, confirming the research of specialists on the wide functionality of saliva, the ability of the salivary glands to selectivity with ion permeability, as well as the mobilization of protective mechanisms. The absence of pronounced changes in the state of oral homeostasis in the initial phase of endocrinopathy indicates the preservation of self-regulation of mineral metabolism in the oral cavity, which ensures relative physiological remineralization of tooth enamel in the event of a cariogenic situation.

In children with a duration of type 1 diabetes from five to ten years, in comparison with children in the comparison group, there was a marked decrease in the rate of salivation ($43.8 \pm 1.8\%$ - $45.6 \pm 2.1\%$), ductility ($34.9 \pm 1.6\%$ - $35.9 \pm 1.8\%$),

increase in viscosity ($79.9 \pm 3.6\%$ - $81.5 \pm 3.9\%$). The destruction of insulin-producing R-cells of the pancreas and the development of absolute insulin deficiency in children with a long experience of type 1 diabetes leads to a violation of the functional activity of the salivary glands, which is manifested in a change in metabolism, hyposalivation, a decrease in immunity (cellular, humoral) in the oral cavity and enamel resistance to the influence of organic acids. The accumulation of carbohydrates in the oral fluid provokes the so-called "explosion" of metabolic processes in the oral cavity, which is manifested by the accumulation of acidic foods, the activation of anaerobic glycolysis. The functional intensity of synthetic processes in the salivary glands, according to the authors, is characterized by a violation of the processes of secretory formation and a decrease in enzyme-excretory function, and a significant increase in glucose levels violates the mineralizing potential and mineralization processes of hard tissues, accelerates demineralization processes, enhances the activity of the microbial flora of the oral cavity, contributing to the imbalance of enzyme systems. A significant shift in the pH level of the oral fluid towards acidosis ($8.4 \pm 0.3\%$ - $9.7 \pm 0.4\%$) in the later stages of endocrinopathy indicates inefficient functioning of buffer systems, depletion of functionality and protective mechanisms of saliva, imbalance of homeostatic reactions in the oral cavity.

Homeostatic regulatory mechanisms are most sensitive to changes in acid-base balance in the oral cavity. This is due to the violation of electrochemical interactions that determine the physiological parameters of saliva (structure, degree of mineralization, rate of ion exchange processes), enzymatic activity, composition (qualitative, quantitative) of microflora, state of cellular (humoral) immunity. In children in the early stages of the development of type 1 diabetes in the phase Compensation for the mobilization of adaptive mechanisms is a balance of homeostatic reactions in the oral cavity. In the later stages of the development of type 1 diabetes in children, there is a decrease in the reserve potential with the involvement of specific adaptation mechanisms that mobilize the functional capabilities of the body. The occurrence of this complex leads to overvoltage adaptive-regulatory mechanisms responsible for homeostatic balance, as well as irreversible morphological changes at the cellular and tissue level.

Experts have proven that the pH level of the oral fluid (the activity of hydrogen ions) plays a key role in the regulation of oral homeostasis. Violation of the structural properties of the oral fluid, an increase in enamel solubility due to a decrease in saturation with HPO_4^{2-} and Ca^{2+} ions, is noted at a critical level ($\text{pH} = 6.2$), when saliva is a demineralizing liquid. Balanced (optimal) for the processes of remineralization (mineralization) of tooth enamel is a slightly alkaline pH value, at which the oral fluid is supersaturated with Ca^{2+} and HPO_4^{2-} ions. In our opinion, the drop in the pH level of the oral fluid (acidosis) with an increase in the experience of type 1 diabetes in children is determined by the following factors: high glucose content in saliva; violation of carbohydrate and transcapillary metabolism; utilization of nitrogenous materials for anabolic reactions that stimulate energy storage; increase in microbial acid production and acidogenic activity of the microflora of plaque and carious cavities; decrease in the efficiency of buffer (bicarbonate, phosphate) saliva systems. The established complex enhances the initial imbalance of the functional reactions of saliva, which are included in the homeostatic mechanisms of the oral cavity, creates tension in the adaptive mechanisms that regulate the acid-base state in the oral cavity, and also reduces the structurally functional acid resistance of tooth enamel. It should be noted that in children with type 1 diabetes in need of sanitation, in comparison with sanitized patients, due to a more significant shift in pH towards acidosis and an imbalance of homeostatic reactions, an aggravation of local disorders in the oral homeostasis system was revealed, and the severity of these changes increases with an increase in the duration of endocrinopathy.

Findings. Systematizing the data obtained, as well as the results of studies by other authors, the formation of the so-called "vicious circle" in type 1 diabetes was revealed. On the one hand, immuno-

metabolic disorders arising from type 1 diabetes, caused by impaired carbohydrate metabolism and neuroendocrine mechanisms of regulation, electrolyte balance disorders, cause a decrease in bone mineral density, destruction of hard tissues of teeth, and changes in biochemical indicators of mineral metabolism, the development of periodontal pathology. With an increase in the length of type 1 diabetes in children, there is a decrease in the structural and functional resistance of the enamel, an increase in the risk of active dental caries, which provides an increase in the intensity and prevalence of carious lesions, as well as changes in the structure of periodontal diseases associated with the appearance of irreversible (destructive) forms (periodontitis). On the other hand, excessive accumulation of toxins in the foci of chronic dental infection (multiple carious lesions, periodontal pockets, mineralized dental plaque), microcirculatory disorders in the tissues of the periodontal complex, insufficiency of local immune protection and phagocytic function, as well as a decrease in colonization resistance to pathogenic microbial flora of the oral cavity significantly aggravate the course of endocrinopathy, increasing, at the same time, resistance to Insulin.

Conclusion. Thus, the expediency of an integrated approach in the treatment of carious lesions of the teeth and periodontal diseases in type 1 diabetes in children using easily digestible calcium preparations in combination with vitamin D3, as well as therapeutic and prophylactic complexes containing minerals, vitamins, synbiotics, adaptogens, sorbents, in the form of rinses, balms, elixirs, applications, ointments, gels with a pronounced antimicrobial, antioxidant, anti-inflammatory effect, will significantly allow facilitate the course of endocrinopathy, increase the level of dental health, reduce the risk of complications and relapses, improve the quality of life of children with endocrine pathology.

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