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# FEATURES OF BIOPHYSICAL PROPERTIES AND COMPOSITION OF ORAL FLUID IN CHILDREN WITH CONNECTIVE TISSUE DYSPLASIA LIVING IN THE CONDITIONS OF HIGH LATITUDES

**ABSTRACT**

The complex clinical laboratory research of the children with connective tissue dysplasia (CTD) living in the North conditions has been done. The obtained data confirmed the existence of particular changes in structure and properties of oral fluid which promoted disturbance of structural homogeneity of solid tissues of teeth and decreased their caries resistance. The examined age groups of children showed biophysical properties of oral fluid characterized by the secretion rate reduction, the increase of saliva viscosity, the dominance of II and III types of microcrystallization, the decrease of remineralizing potential of oral fluid. The high-quality changes of common protein decrease concentration in children with a severe DCT form have been noted in children's saliva. Besides, the activity decrease of alkaline phosphatase irrespective of case severity has been revealed. The carried cationic and anionic spectral microanalysis of oral fluid has revealed the decrease in concentration of cations of magnesium and calcium which are important in teeth enamel saturation by mineral components of hydroxyapatite. Magnesium is a coenzyme of protein structures and generally concentrates in the bone tissue, dentine and enamel of teeth. Besides, it participates in formation of normal structure of connective tissue and its deficiency in prenatal development influences on the development of connective tissue dysplasia syndrome. The revealed features of structure and properties of oral fluid can be consider specific regional biological risk factors of the development of pathological processes of organs and tissues of oral cavity in children with DCT living in the North conditions that on the other hand has been confirmed by the obtained data of the high level of teeth caries in the examined age groups of school children and the high intensity level in key age group of 12-year-old children by WHO. In this regard, the complex treatment-and-prophylactic events and rehabilitation of children have to be organized taking into account the revealed biophysical features of properties and composition of oral fluid among school children with DCT living in the Republic of Sakha (Yakutia).

**Keywords:** dysplasia of connective tissue, organs and tissues of oral cavity, oral fluid, caries of teeth, prophylaxis of dental diseases.

## INTRODUCTION

There is still high level of dental diseases among various age groups of the population [1, 2]. Aggressive factors of external and internal environment affect the development of dental diseases [3- 5]. Among the common risk factors, the congenital dysgenesis, which according to different authors has a high level of prevalence which indexes reach up to 80%, is an important value in pathogenesis of pathological processes of organs and tissues of oral cavity [6- 8]. Organs and tissues of the oral cavity have a connective tissue origin at the morphogenetic level [9, 10]. At the same time frequent phenotypical symptoms of the dysplasia of connective tissue (DCT) in the oral cavity are dentoalveolar anomalies, Gothic palate, caries of teeth, diseases of parodont and temporal - mandibular joint (TMJ), etc. [11, 12].

It should be noted that the organization and optimization of treatment-and-prophylactic actions among children with DCT is based on knowledge of its pathogenetic mechanisms and manifestations in organs and tissues of the oral cavity and also maxillofacial area. Taking it into account, we've made complex studying of properties and composition of oral fluid among children of school age with the proven diagnoses of DCT, especially there were not similar researches in the conditions of the Republic of Sakha (Yakutia).Research aim was studying of features of structure and properties of oral fluid among children with connective tissue dysplasia, living in the North conditions.

## MATERIALS AND METHODS

The complex clinical laboratory research of children of school age from 10 to 14 years in educational institutions № 31 of "City Yakutsk", and also State Budgetary Institution of the Republic of Sakha (Yakutia) "Neurologic children's rehabilitation center" was made (Yakutsk). In total 494 children were examined. The affect of solid tissues of teeth caries was estimated by the indexes of relevance and intensity. The assessment card of the dental status was used for the research results (WHO, 1997). Intensity was determined by indexes of CFE and DC, teeth that were filled, extracted and affected with caries, and also their surfaces. The structure and properties of oral fluid were determined by indexes of salivary discharge (n=182); viscosities of oral fluid with application of viscosimeter VK-4 by N. V. Zimkin's method with coauthors (1955), (n=182); microcrystallization types by P. A. Leus's method (1977), (n=182); the acid-base equilibrium was studied on the device "713 pH Meter» of Metrohm company (Germany), (n=182); the cationic and anionic electrophoresis of the mixed saliva was carried out on the device of system of capillary electrophoresis «Kapel-104T» (Russia), (n=182); protein (n=494), alkaline phosphatase and relative density (n=182) on the device «Uriscan Optima» of the YD Diagnostics company (Korea). Statistical processing of clinical material was carried out with application of standard methods of variation statistics with calculation of standard mean square error by packages of the application programs «Microsoft Excel» 2007 (Microsoft Corporation). The received results were grouped in set of identical signs. A critical significance level when checking statistical hypotheses was $p \leq 0,05$.

## RESULTS AND DISCUSSION

The analysis of the received results of study of biophysical properties of oral fluid in the examined age groups of children with DCT characterized the existence of their particular features (Tab. 1). So, the index of viscosity in age groups demonstrated its increase where data varied ranging from 3.03±0.05 to 3.31±0.07 units (optimum viscosity index – 4.16 units). It should be noted that the viscosity increase of oral fluid in turn reduces saliva rate (the best value of secretion rate – 0.40 ml/min.), and it was confirmed by the obtained data. Despite it, the acid-base balance in the oral cavity was in its optimum indexes (the best value of pH 6.5-7.5). It should be noted that the above changes of properties of oral fluid in children of school age to some extent make negative impact on microcrystallization types. III DCT type dominates in structure of microcrystallization types in children which made in average 62.47±0.53% that in turn, defined the unfavorable prognosis for the development of pathological processes of hard tissues of teeth of demineralizing character in the examined age groups of children. The revealed features of microcrystallization types affected the decrease of the remineralizing potential of oral fluid.

It is known that children with DCT determine the quantitative and qualitative changes of composition of oral fluid (Tab. 2). So, the particular tendency of changes of concentration of protein in saliva depending on DCT severity has been revealed. At the same time children with mild DCT form of all age groups had the concentration within reference values (3.37±0.38 to 5.39±0.17 g/l). These data were interpreted as the increase of protein of moderate severity in all age groups of the examined children (6.80±0.13 to 9.58±0.26 g/l). The most maximal changes of protein content in oral fluid were noted in children with severe DCT degree which were characterized as its decrease where indexes varied up to 1.43±0.08 g/l within digital values 1.25±0.04 (optimum content of the common protein in the mixed saliva 1.56-6.30 g/l). It should be noted that the alkaline phosphatase has important value in metabolic process of organs and tissues of the oral cavity. The indicators of alkaline phosphatase in oral fluid in the examined age groups of children with CTD characterized the decrease of its activity. So, minimum activity was defined by age group of 12-year-old children (31.9±0.69 units/l), and the maximal activity among 10-

Table 1

**Properties of oral fluid among the examined age groups of children with CTD**

| Age, (years) | pH | Viscosity, (units) | Salivation speed, (ml/min) | Types of microcrystallisation, (%) | | |
|---|---|---|---|---|---|---|
| | | | | I | II | III |
| 10 (n=37) | 7,12±0,06 | 3,03±0,05 | 0,25±0,01 | 6,09±3,93 | 27,33±3,04 | 66,58±1,39 |
| 11 (n=34) | 7,05±0,04 | 3,11±0,06 | 0,31±0,02 | 14,71±3,49 | 29,42±2,88 | 55,87±1,80 |
| 12 (n=37) | 6,81±0,07 | 3,17±0,02 | 0,33±0,04 | 15,21±3,55 | 33,17±2,79 | 51,62±2,02 |
| 13 (n=39) | 6,72±0,06 | 3,23±0,08 | 0,35±0,06 | 12,17±3,67 | 18,12±3,42 | 69,71±1,26 |
| 14 (n=35) | 7,05±0,05 | 3,31±0,07 | 0,37±0,05 | 5,71±3,78 | 25,72±2,98 | 68,57±1,26 |
| Average value | 6,95±0,03 | 3,17±0,02 | 0,32±0,03 | 10,78±1,27 | 26,75±1,04 | 62,47±0,53 |

Table 2

**Composition of oral fluid among children with connective tissue dysplasia living in the conditions of high latitudes**

| Age | Protein, (g/L) | | | Number of examinees | Alkaline phosphatase, (units/l) | Relative density (specific gravity), g/ml |
|---|---|---|---|---|---|---|
| | DCT I stage | DCT II stage | DCT III stage | | | |
| 10 (n=103) | 4,53±0,01 | 9,58±0,03 | 1,25±0,03 | n=37 | 51,5±0,07 | 1,005±0,08 |
| 11(n=98) | 4,33±0,02 | 6,80±0,02 | 1,32±0,04 | n=34 | 40,2±0,05 | 1,007±0,08 |
| 12 (n=96) | 4,81±0,01 | 6,94±0,05 | 1,41±0,08 | n=37 | 31,9±0,06 | 1,006±0,01 |
| 13(n=102) | 5,39±0,01 | 6,89±0,06 | 1,37±0,07 | n=39 | 43,8±0,07 | 1,007±0,06 |
| 14 (n=95) | 3,37±0,04 | 7,42±0,04 | 1,43±0,08 | n=35 | 46,2±0,08 | 1,007±0,06 |
| Среднее значение | 4,02±0,01 | 7,52±0,01 | 1,35±0,01 | Среднее значение | 30,1±0,16 | 1,006±0,01 |

Table 3

**Cationic and anionic spectral microanalysis of oral fluid among the examined age groups of children with connective tissue dysplasia**

| Cations | Concentration, mmol/l | | | | |
|---|---|---|---|---|---|
| | 10 лет n=37 | 11 лет n=34 | 12 лет n=37 | 13 лет n=39 | 14 лет n=35 |
| Ammonium | 2,32±0,04 | 2,82±0,02 | 2,93±0,01 | 3,24±0,04 | 3,27±0,03 |
| Potassium | 5,79±0,04 | 6,18±0,02 | 6,23±0,02 | 5,89±0,03 | 6,27±0,02 |
| Sodium | 6,46±0,05 | 6,32±0,01 | 6,51±0,03 | 6,34±0,01 | 6,49±0,04 |
| Lithium | 0,021±0,02 | 0,023±0,01 | 0,024±0,01 | 0,023±0,01 | 0,025±0,03 |
| Magnesium | 0,48±0,08 | 0,51±0,04 | 0,55±0,01 | 0,54±0,04 | 0,52±0,03 |
| Strontium | 0,071±0,02 | 0,064±0,04 | 0,072±0,01 | 0,065±0,04 | 0,072±0,02 |
| Barium | 0,26±0,03 | 0,29±0,02 | 0,27±0,05 | 0,31±0,04 | 0,28±0.03 |
| Calcium | 0,36±0,02 | 0,37±0,07 | 0,36±0,09 | 0,37±0,08 | 0,35±0,7 |
| Anionics | Concentration, mmol/l | | | | |
| Chloride | 2,35±0,02 | 2,38±0,01 | 2,36±0,03 | 2,33±0,03 | 2,39±0,07 |
| Nitrite | 0,005±0,002 | 0,007±0,008 | 0,006±0,001 | 0,006±0,001 | 0,008±0,004 |
| Fluoride | 0,03±0,01 | 0,04±0,08 | 0,03±0,01 | 0,05±0,004 | 0,03±0,01 |
| Phosphate | 7,45±0,07 | 7,53±0,03 | 7,37±0,01 | 7,40±0,09 | 7,39±0,03 |
| Sulfate | 0,13±0,01 | 0,14±0,03 | 0,13±0,01 | 0,15±0,04 | 0,13±0,01 |
| Nitrate | 0,025±0,008 | 0,025±0,008 | 0,026±0,004 | 0,026±0,004 | 0,024±0,001 |

year old children (51.5±0.71 units/l). At the same time the average index in the examined age groups of children was 30.1±0.42 units/l (optimum indicator of activity of alkaline phosphatase 54-114 units/l at pH 7.0 and above). The analysis of the obtained data by indexes of the relative density of oral fluid did not reveal features where data fluctuated within digital values from 1.005±0.08 g/ml to 1.007±0.06 g/ml, and the average value of groups was at the level of 1.006±0.01 g/ml (optimum index of the relative density 1.001-1.017 g/ml).

The saturation of oral fluid with various mineral components is important in the development of pathological processes of solid tissues of teeth of demineralizing character (Tab. 3). Taking it into account we carried out the cationic and anionic spectral analysis of oral fluid where the data characterizing the particular disbalance of micro and macroelements were obtained. So, the most maximal indexes of concentration were ammonium, potassium, sodium and they had on average 2,91±0,05, 6,07±0,02 and 6,42±0,01 mmol/l among cations. Further on concentration there were lithium (0,023±0,04), strontium (0,068±0,06) and barium (0,28±0,04 mmol/l).

It is known that children with undifferentiated form of connective tissue dysplasia in the oral fluid were characterized by decreased content of magnesium and calcium and to some extent it was a marker of the congenital dysgenesis. In our study children with CTD living in the conditions of high latitudes showed the decrease of cations concentration of magnesium, calcium in the oral fluid and they were on average in age groups 0,52±0,05 and 0,36±0,02 mmol/l (optimum index of magnesium 0,58 mmol/l; calcium – 1,45 mmol/l). The revealed features of decrease in concentration of these cations among children with DCT made negative impact on configurational regularity of hard tissues of teeth and reduced caries resistance.

The anionic composition of oral fluid did not reveal any special changes. So, the maximal concentration were revealed on average among chlorides (2.36±0.05) and phosphates (7.42±0.01 mmol/l).

It should be noted that the decrease of calcium concentration in the oral fluid contributed to the decrease of the activity of alkaline phosphatase which participated in maintaining calcium - phosphorus coefficient within its normal values. Besides, the revealed features of biophysical properties and composition of oral fluid are specific regional biological risk factors of the development of teeth caries that to some extent is confirmed by the high level of pathological processes of hard tissues of teeth of demineralizing character among the examined children (91.13+0.10%) and high level of caries intensity among 12-year-old children (5.78+0.21).

## CONCLUSION

The received results of the complex clinical laboratory research of structure and properties of oral fluid in children with CTD characterize the reduction in the secretion rate, the increase of viscosity, the decrease in the remineralizing potential and activity of alkaline phosphatase, weakening of the common protein among children with severe degree, and also the poor content of cations (calcium, magnesium). These features of structure and properties of saliva in children with CTD are biological risk factors of the development of pathological processes of organs and tissues of the oral cavity which are important for complex treatment-and-prophylactic and rehabilitation work.

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