

## Dynamics of Changes in Bone Densitometric Parameters and the pH Level of Oral Fluid Among Children with Juvenile Idiopathic Arthritis During the Use of Developed Treatment and Prevention Complex

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**Abstract.** Prevention and treatment of major dental diseases among children with juvenile idiopathic arthritis is quite a difficult task. It is necessary to develop appropriate therapeutic and preventive measures, taking into account the pathogenetic factors and peculiarities of such somatics. Among fifty-five children with juvenile idiopathic arthritis aged 6-10 years, the main densitometric parameters of bones were determined and the pH stability of the oral fluid was assessed against the background of the use of the developed treatment and prevention complex, which includes modern, effective, safe, and affordable medicines.

As a result, after a year of using the treatment and prophylactic complex, an improvement in the densitometric indicators of bone tissue was observed among children, which indicated an improvement in their mineralization and structure, as well as a normalization of functional adaptation and compensatory reactions in the body, which maintain the stability of the pH of the oral fluid.

**Keywords:** juvenile idiopathic arthritis, densitometry, drugs, toothpaste, pharmacotherapy, treatment and prevention complex, multidisciplinary studies.

**Introduction.** Juvenile idiopathic arthritis (JIA), also known as juvenile rheumatoid arthritis, is the most common type of arthritis among children. Juvenile idiopathic arthritis causes persistent pain, swelling, and stiffness mainly in large joints. Mandatory criteria for the diagnosis of juvenile idiopathic arthritis are the presence of this disease before the age of 16 and its duration for more than six weeks [1-4]. Juvenile arthritis leads to delayed physical development, disability, reduced life expectancy and also significantly affects the dental status of children [5-8].

Prevention and treatment of major dental diseases in children with juvenile idiopathic arthritis is quite a difficult task [9,10]. Therefore, in the presence and treatment of dental diseases in children with juvenile rheumatoid arthritis, it is necessary to develop appropriate therapeutic and preventive measures that take into account pathogenetic factors and peculiarities of such somatics.

**The purpose of this work** was to study individual biophysical indicators of oral fluid and bones among children with juvenile idiopathic arthritis and to establish the effect of the proposed treatment-prophylactic complex on them.

**Materials and methods.** Fifty-five children with juvenile idiopathic arthritis aged 6-10 years participated in clinical studies (main group – 30 people, comparison group – 25 people). The diagnosis was established by a pediatrician who prescribed basic therapy according to the standards of treatment of juvenile idiopathic arthritis. The children of the comparison group underwent oral hygiene and professional hygiene. The children of the main group additionally received the developed treatment and prevention complex (Table 1).

The main densitometric indicators of bone quality were determined using the "Sonost 2000" densitometer [11].

**Table 1.** Treatment and prevention complex for children 6-10 years old with juvenile idiopathic arthritis.

Used drugs	Dosage	Terms of use	Mechanism of action
"Ismizhen"	1 tablet per day under the tongue	10 days for 3 months 2 times a year	immunomodulating
"BioGaya ProDentis"	1-2 pastilles after brushing teeth daily	10 days 2 times a year	normalizes microbiocenosis
Vitamin-mineral complex Alfavit Shkoliar for children from 7 to 14 years old	1 tablet of each type (No. 1, No. 2, No. 3) once a day during meals	1 month 2 times a year	complex of microelements and vitamins
"Atoksil"	1 sachet/50-100 ml of water 3 times a day	10 days 3 times a year	detoxification, antimicrobial action
"Querticin"	1 g/100 ml of water 2 times a day	2 months 2 times a year	adaptogen, antioxidant, membrane-stabilizing effect
"Quertulin gel"	locally in the form of applications	10 days 3 times a year	regulation of microbiocenosis in the oral cavity
toothpaste "Sensodyne Pronamel for children"	once a day (in the morning)		caries prevention
toothpaste "R.O.C.S. teens"	once a day (in the evening)		normalization of the microflora of the oral cavity

Oral fluid pH was measured using a PHscan 30 ionometer.

The STATISTICA 6.1 computer program was used for statistical processing of the obtained results to assess their reliability and measurement errors.

The study is a fragment of the scientific research works of the Higher Private Educational Institution "Lviv Medical University" on the topic of "Improving the system of drug circulation during pharmacotherapy on the basis of evidentiary and forensic pharmacy, organization of technology, biopharmacy and pharmaceutical law" (state registration number 0120U105348, implementation period 2021-2026).

**Results and discussion.** Our study determined the main densitometric indicators of bone quality in children with juvenile idiopathic arthritis during their comprehensive dental treatment [12]. The quality of bone tissue is determined by its micro- and macroarchitectonics, material mineralization and collagen bonds, which also determines its mechanical properties. The speed of ultrasonic waves propagation (SOS) in bone depends, first of all, on the density of bone tissue and its mineralization. Broadband ultrasonic wave attenuation (BUA) is determined, first of all, by the scattering and reflection of the wave in the bone, which is related to its structure and architecture. In a complete bone, higher-frequency ultrasound oscillations fade more strongly than low-frequency oscillations, since their wavelength approaches the dimensions of the existing structural parameters of the bone, and they are more strongly scattered and reflected than longer-wavelength low-frequency waves, which are able to bend bone trabeculae due to diffraction [11].

The results of the study of the main densitometric indicators of bone quality in children with juvenile idiopathic arthritis, who participated in this study, and their change under the influence of the treatment and prevention complex are shown in Table 2.

From the given data, we can see that among children aged 6-10 years who suffer from juvenile idiopathic arthritis, at the initial stage, the speed of the ultrasonic wave in the calcaneus (SOS) was, on average, lower than the average statistical norm by 36.14 m/s. This indicates that juvenile idiopathic arthritis has a rather significant effect on the general mineralization of children's bone tissues. Comprehensive treatment and preventive measures carried out during the year in the

main group led to an increase in the SOS indicator, on average, by 41 m/s, which indicates an improvement in bone tissue mineralization (Table 2).

**Table 2.** Densitometric indicators of bone quality among children 6-10 years old with juvenile idiopathic arthritis in the process of complex dental treatment,  $M \pm m$ .

Groups	Indexes	SOS, m/s	BUA, dB/MHz	BQI, conditional units
Average statistical norm				
		1563,4±10,3	55,2±4,1	97,7±5,9
<b>Initial state</b>				
Main group, n=25		1527,26±10,8 p>0,05	14,09±5,1 p>0,05	75,28±5,4 p>0,05
Comparison group, n=20		1528,34±9,8	17,26±5,3	79,2±6,1
<b>After 1 year of observation</b>				
Main group, n=25		1568,2±8,4 p<0,005	28,22±6,4 p<0,05	94,26±6,3 p<0,05
Comparison group, n=20		1534,36±9,4	17,1±6,3	75,35±6,70

Note: p is an indicator of the reliability of differences from the comparison group.

The index of attenuation of the ultrasonic wave in the calcaneus, which characterizes its architecture, at different frequencies (BUA) among children aged 6-10 years with juvenile idiopathic arthritis found to be lower than the norm for the group by 41.11 dB/MHz, which indicates certain changes in the structure of bone tissues associated with osteopenia and osteoporosis. These processes lead to an increase in the distance between the trabeculae of the bone, a decrease in their thickness, which, in turn, leads to an increase in the scattering and reflection of low-frequency ultrasonic waves in the bone (the phenomenon of the wave enveloping the trabeculae due to the phenomenon of diffraction decreases). An increase in the attenuation in bone of the ultrasonic wave at low frequencies leads to a decrease in the gradient of wave attenuation at low and high frequencies and, therefore, a decrease in BUA.

Carrying out treatment and preventive measures two times a year led to an increase of observations among children in the main group of the BUA index by almost 2 times per year, which also indicates a certain improvement in the structure of bone tissues. At that time, this indicator did not change reliably in the comparison group (Table 2).

The bone quality index (BQI) is a derivative of the SOS and the BUA, calculated by a programmed microprocessor, and is an integral characteristic of bone quality. In the initial condition, the BQI index was 22.48 conditional units lower than the norm among children aged 6-10 years with juvenile idiopathic arthritis, and as a result of the medical and preventive measures carried out in the main group of children, it increased by 18.98 units during the year of observation. It is obvious that the increase in the BQI index was determined by the increase in the BUA and the SOS indexes, that is, by the improvement of both the bone architecture and its density among children with juvenile idiopathic arthritis who received the treatment and prevention complex. In the comparison group, the relevant indicators did not change reliably (Table 2).

The assessment of the stability of the pH of the oral fluid ( $\Delta$ pH), as one of the indicators of the level of non-specific resistance in the body and in the oral cavity in particular, was carried out according to the method based on the fact that fluctuations in the value of pH ( $\Delta$ pH) in individual samples are a representative characteristic of the instability of homeostasis and the inability of the body to maintain acid-alkaline balance in the oral cavity [13]. At the same time, the values of  $\Delta$ pH in the range of 0.2-1.0 usually correspond to low caries resistance in children, and values of 0.01-0.1 to high caries resistance. To estimate the  $\Delta$ pH value, five 1 ml samples of oral fluid were taken from each patient, in which the pH value was determined using an ionometer immediately after sampling. Then the average value of  $\Delta$ pH and the confidence interval of deviations ( $\Delta$ pH) from the average value were calculated, taking into account the Student's coefficient for five measurements and a confidence probability of 0.95. Data were averaged by group.

Table 3 presents the results of fluctuations in the hydrogen potential (pH) of the oral fluid of children with juvenile idiopathic arthritis in individual samples ( $\Delta\text{pH}$ ) during complex dental treatment [13].

**Table 3.** Average indicators of the confidence interval of fluctuations in the pH value of oral fluid ( $\Delta\text{pH}$ ) among children aged 6-10 years old with juvenile idiopathic arthritis during complex dental treatment,  $M\pm m$ .

Terms of observation \ Groups	Main group n=25	Comparison group n = 20
Initial state	0,30±0,03 p>0,1	0,29±0,02
After 6 months	0,19±0,04 p<0,001	0,30±0,03
After 1 year	0,15±0,02 p<0,001	0,31±0,04

Note: p is an indicator of the reliability of differences from the comparison group.

A number of functional reactions in the body are responsible for the homeostasis of the oral fluid, which normally maintains a certain level of its pH. The presence of significant fluctuations in the pH value of the oral fluid ( $\Delta\text{pH}$ ) is one of the risk factors for dental caries. The obtained data indicate that among children aged 6-10 years old with juvenile idiopathic arthritis, the basic therapy carried out in the comparison group was not able to reduce the confidence interval of pH fluctuations in individual samples, which was quite large in the initial state. At the same time, the proposed comprehensive prevention of complications in the dental treatment of children with juvenile idiopathic arthritis made it possible after 6 months to reduce the value of  $\Delta\text{pH}$  in the main group of children 6-10 years old by 1.58 times, and in 1 year to reduce the value of  $\Delta\text{pH}$  in the main group of children 6-10 years old in 2 times, which indicates a certain normalization of functional adaptive and compensatory reactions that maintain the stability of the pH of the oral fluid. At the same time, in the comparison group, the average value of  $\Delta\text{pH}$  remained high (Table 3).

The clinical data obtained during the dental examination and treatment indicated the need for further multidisciplinary medical and pharmaceutical, clinical, immunological, organizational and legal researches based on the principles of evidence-based medicine and evidence-based pharmacy. The relevance of such studies is increasing against the background of covid, post-covid, long-covid and comorbid disorders in order for the life of the children's population, in particular, patients with juvenile idiopathic arthritis, to be socially adapted and personalized with the use of modern, effective, safe, and economically available medicines [14-18].

**Conclusions.** The use of the developed treatment-prophylactic complex among children aged 6-10 years with a diagnosis of juvenile idiopathic arthritis made it possible to improve the densitometric indicators of bone tissue, which indicates an improvement in their mineralization and structure, and also led to the normalization of functional adaptive and compensatory reactions in the body that maintain the stability of oral pH liquid. Clinical data obtained during dental treatment indicated the need for further multidisciplinary medical and pharmaceutical, clinical, immunological, organizational and legal studies.

**Conflict of interests.** The authors confirm that they are the authors of this work and have approved it for publication. The authors also certify that the obtained clinical data and research were conducted in compliance with the requirements of moral and ethical principles based on medical and pharmaceutical law, and in the absence of any commercial or financial relationships that could be interpreted as a potential conflict of interest.

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**Ethical approval.** Ethical clearance was obtained from the administration of Higher Private Educational Institution "Lviv Medical University". A permission statement for conducting the experiments was received from the administration of Higher Private Educational Institution "Lviv Medical University". Before any data collection, the main purpose of the study was clearly explained to each department (concerned personnel).

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