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PROSPECTS OF USING THE METHOD OF X-RAY FLUORESCENCE ANALYSIS AS A METHOD OF CONTROL OF MICROELEMENT BALANCE IN PATIENTS WITH DIFFUSE ALOPECIA

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ABSTRACT

The possibility of using the method of X-ray fluorescence analysis to assess the bioelemental status of the human organism of people with diffuse alopecia is shown. In modern conditions of life support the increase level of ecological discomfort of the environment exeeds the potential protection capacity of the body and leads to the stress and disruption of adaptation with all that it implies, in some cases, it is expressed as alopecia.

Keywords: *endoecological status, environmental maladjustment, the method of X-ray fluorescence analysis*

INTRODUCTION

On boundary of the 20th–21st centuries the opportunity to conduct research on the relation of chemical elements in the "man-environment" system appeared [1]. The problem of microelements (ME) and microelementosis is one of the most topical problems in modern biology and medicine. Since the full content of essential elements and the minimum, which does not threat the disruption of adaptation mechanisms of the organism, the presence of toxic and semi-toxic minerals are an essential component of the normal functioning of the organism as a whole. Taking into account complex antagonistic and synergistic interaction between the elements, the clinical manifestations of microelementosis cause difficulties in the timely interpretation of pathological states. On the basis

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of this provision, the adequate diagnosis of ME imbalance should be directed to the precise quantification of minerals in indicator biosubstrates of the human, while the assessment of the manifold ways of the regulation of homeostasis of microelements should be based on the differential diagnosis and treatment of microelementosis [2, 5]. Hair and nails, the growth and development of which require optimal quantity and the ratio of minerals can exemplify the the development of pathological changes in the imbalance of macro- and microelements. In particular, the manifestation of these states can be diffuse alopecia. Diffuse alopecia and onychodystrophy are among the most common diseases encountered in practice of a dermatologist, they have heterogeneous etiology and pathogenetic mechanisms of development and changes in histologic pattern. Among the diseases of skin, hair lesion is at the frequency of approximately 4%, of which diffuse alopecia constitutes a large portion. According to U.S. researchers, annually 650 thousand people turn to the doctor complaining of hair loss. In addition, a large number of patients consider intensive hair loss to be a normal condition and do not apply to medical facilities. At the same time, about 1% of the population observed their hair loss at least once. The frequency of diffuse alopecia in men and women is not the same. The symptoms, observed with diffuse alopecia and onihodistrophy (change in appearance, the structure of hair and nail plates) lead to the development of psychosocial maladjustment and decreasing of life quality. Mineral hair analysis allows to measure changes in the metabolism of microelements in a given period of time and demonstrate the dynamic picture of the elements balance of the organism. Scientific publications describe the results of the quantitative determination of calcium in the hair, the dependence of this index in healthy individuals on gender, age, ethnicity, body mass index [8]. In view of complex antagonistic and synergistic mutual influences between elements, the picture of intoxication or imbalance of elements, accompanied by a specific clinic can be very complex and difficult to interpret. In this case it is very important to have an adequate diagnosis of microelementosis related, primarily, to the precise quantification of elements in the indicator biosubstrates of humans [7]. Elemental composition of the blood remains under the stiff influence of the systems that regulate the homeostasis of the organism, so deficiency of vital microelements such as calcium, etc., is clearly seen in the blood later than the bone, tooth dentin, hair and nail plates. While the content of microelements in the blood can change only briefly or not change at all, the mineral hair analysis allows to measure changes

in the metabolism of microelements in a given period of time and demonstrate the dynamic picture of the elements balance of the organism. The value of the study of the mineral profile of the hair. The methods of mineralgram assessment [6]. Currently, there is no doubt about the important role of microelements in the diverse functions of the macroorganism, and each cell individually. The full content of essential elements and the minimum which does not threat the disruption of adaptation mechanisms of the organism, the presence of toxic and semi-toxic elements constitute one of the most important components of the normal functioning of all organs and systems in general. An imbalance of essential macro- and microelements in the human organism leads to pathological states microelementosis [5]. An example is the gradual diffuse hair loss and changes in nail plates on the dystrophic type [10]. In the light of the review of data on the role of external factors in phenotyping of various diseases: a great attention must be paid to the study of complex ecobiologic effects on macroorganisms. Correction of patient's microelementosis can be comparable to the role of genetic factors in the formation of health [9]. All living organisms by 99% are composed of the 12 most common "structural" elements that play an important role not only in physiological processes, but also participate in the development of pathological processes and the formation of the adaptive response [4]. Methods for determining the ME are extremely complex. The difficulties are related to laboratory measurements of the low concentration of ME, to pollution that gets into the object of study of the environment, as well as reagents and instruments, with the possibility of linking ME with other substances contained in the products and tissues [3]. At the present time the following methods of ME measurement and identification are successfully used: spectrometry and spectrography (emission spectrography, atomic absorption spectroscopy, chromatography-mass spectrometry). It should be noted that among the diagnostic biosubstrates hair has the highest informativity as to assess the impact of toxic substances as to determine the level of a number of essential macro- and microelements in the organism. Hair is a cell substrate and the second tissue on metabolic activity, as well as it is characterized by a fixed growth dynamics (0.2–0.5 mm per day) and contains information about the dynamics of metabolism. Available data show that the determination of microelements in the hair can be used as a screening method and reflect the microelement status of the organism as a whole [11].

The objective of the work is to show the possibilities of the X-ray fluorescence analysis as a method of control of a bioelemental state if there is alopecia.

MATERIALS AND METHODS

60 men and women in the age from 20 to 50 served as an observed group.

To assess the balance of microelements, the X – ray fluorescence analysis was used, which does not require complex sample preparation, does not consume sample substance, does not change the chemical composition, it gives a possibility to analyze the same sample as many times as necessary and avoid losses. And, it is very important that the quickness of information receiving about the object under the study does not require significant costs. It is based on a technique that determines the chemical elements in the bioassays (hair) by XRF on the device CEP-01 - MVI. MN 3730-2011.

Preparation of samples for measurement

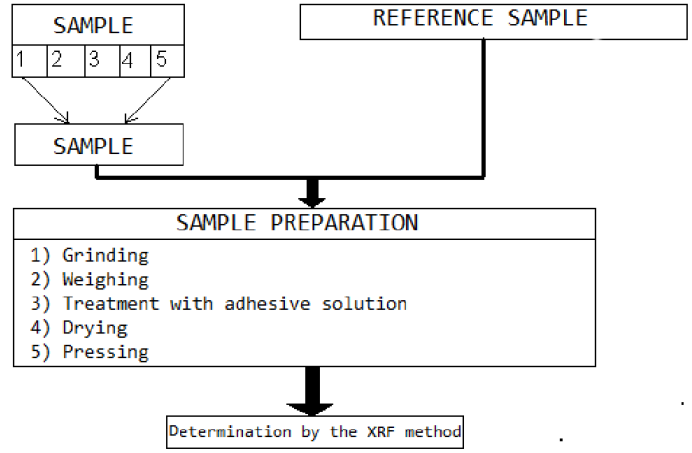

Figure 1. Stages of sample preparation for XRF.

The method of the X-ray fluorescence analysis used in the instrument is based on measuring the intensity of the characteristic X-ray radiation of the atoms of a chemical element when excited by X-rays using a miniature X-ray tube. The derivable spectrum consists of a set of analytical lines ranging from 1 to 40 keV. Registration of analytical intensities is carried out by means of a multichannel spectrometer with the energy dispersive solid-state detector (Si-pin diode) with a thermionic cooling. Specialized software allows us to construct the most probable model of the spectrum, to detect analytical spectral lines in the presence of a large number of elements in the sample (15–30 elements), to determine the mass concentration of the element, the exact weight of the object, and thus determine the concentration of elements in the sample. For the processing of the spectra on a computer, a program processing X-ray fluorescence spectra MK_RE_06 is used. It is intended for the treatment of X-ray spectra of soil, plant, and biological samples of hair, the formation of a unified report on the elemental composition and concentration characteristics.

Statistical analyses were conducted by means of dispersion and correlation analyses in the package *Microsoft Office Excel*.

RESULTS AND DISCUSSION

Received data are presented in Tables 1–4.

Table 1. Quantitative content of micro-, macroelements in the organism of women according to the age (the data received with the help of the XRF method by hair), in mcg/ g *

Indicators	Calcium	Potassium	Strontium	Zink	Copper	Ferrum	Selenium
Age group 20–26, n = 11							
Average	1889	92	3.9	189.6	21.6	15.8	0.9
Min-Max	330–4140	17–163	0.8–10.3	57–351	4.8–67	7.5–26	0.5–1.6
Age group 27–38, n = 13							
Average	1970	125	3.2	169	22.7	18.2	0.9
Min-Max	496–3291	57–232	0–5.8	91–325	5–88	7.6–233.	0.3–3.0
Age group 40–48, n = 7							
Average	1689	75.3	2.9±1	137.5	15.3	15.4	0.6
Min-Max	585–4155	52–141	0.1–6.3	85.3–175	10.1–23.	3.0–30.1	0–1.1
Reference Values							
	550–1700	70–170	0–3	120–200	9–30	15–35	0.3–1.2

* Error in the determination of chemical elements does not exceed 15%

Table 2. Quantitative content of micro-, macroelements in the organism of men according to the age (the data received with the help of the XRF method by hair), in mcg/ g *

Indicators	Calcium	Potassium	Strontium	Zink	Copper	Ferrum	Selenium
Age group 20–26, n = 11							
Average	620	109	1.7	125.4	7.6	18.3	0.9
Min-Max	245–1340	26–143	0.5–2.4	96–152	5.0–9.4	12.5–22.5	0.5–1.2
Age group 27–38, n = 13							
Average	489	129	2.4	125.9	10.2	17.2	1.0
Min-Max	89–163	56–255	0.6–4.4	72–198	5.3–17.5	9.8–22.5	0.4–1.8
Age group 40–48, n = 7							
Average	700	82.6	3.3	121.4	16.9	14.4	0.5
Min-Max	536–921	66.5–102.5	1.7–5.0	96–180	7.3–24.6	5.7–20.9	0.1–0.7
Reference Values							
	400–800	70–170	0–3	120–200	9–30	15–35	0.3–1.2

* Error in the determination of chemical elements does not exceed 15%

Table 3. Quantitative content of heavy metals according to the sex and age (the data received with the help of the XRF method by hair), in mcg/ g *

Sex	N	Indicators	Свинец	Мышьяк	Ртуть
Age group 20–26					
F	11	Average	2.2	0.3	0.5
		Min-Max	0.8–5.7	0–1.2	0–1.0
M	8	Average	1.5	0.3	0.5
		Min-Max	0–4.3	0–0.5	0.1–0.8
Age group 27–38					
F	13	Average	2.7	0.5	0.5
		Min-Max	0.9–4.5	0–2.0	0.1–1.0
M	14	Average	2.5	0.5	0.5
		Min-Max	0–4.0	0–1.0	0.1–0.8
Age group 40–48					
F	7	Average	4.0	0.2	0.2
		Min-Max	0.8–5.3	0–1.0	0–0.8
M	8	Average	2.6	0.3	0.3
		Min-Max	0.4–4.3	0–0.8	0.1–0.5
Reference Values			0–5	0–2	0–2

* Error in the determination of chemical elements does not exceed 2–5%

Table 4. The ratio of chemical elements Ca / K, according to the age and sex

Age	Female	Male
20–26	20	6
27–38	16	4
40–48	22	8
Border of the optimal ratio	2–5	

The authors note that the assessment of the relations of chemical elements in the size of their correlations expands diagnostic possibilities [10]. The coefficient Ca / K can be used to evaluate the activity of calcium of regulating hormones as the microelement expression of their effect. It is assumed that the increase in its value more than 5, points out a decline of the calcitonin role in calcium metabolism [12]. As it can be seen from the presented data, the marked sex differences of the ratio of calcium and potassium with a multiple excess in the organism of women of different age-groups are observed. The disparity increases with a high level of calcium typical of women. There is a high calcium content in all the age groups of females, 1.8 times the upper limit of the norm with diffuse alopecia, we can assume that there has been an increase in the loss of hair and the development of predeficit of calcium in the organism. The increase of this value in some cases 4–5 times points out a disorder of hormonal activity of the endocrine glands that regulate calcium metabolism. The indicators of quantitative content of zinc, copper, iron, selenium testify about a degree of antioxidant protection, and men have this degree more reduced than women.

CONCLUSION

In modern conditions of life support, the level of environmental discomfort exceeds the protection capacity of the organism and leads to the tension and disruption of adaptation with all that it implies, in some cases, it is expressed as alopecia.

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