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КЛИНИКО-ЭКСПЕРИМЕНТАЛЬНОЕ ОБОСНОВАНИЕ ВЫБОРА ЗУБНЫХ ПАСТ НА ОСНОВАНИИ МОНИТОРИНГА СОСТАВА РОТОВОЙ ЖИДКОСТИ У ЖИТЕЛЕЙ ЭКОЛОГИЧЕСКИ НЕБЛАГОПРИЯТНЫХ РАЙОНОВ

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Аннотация

Жители экологически неблагоприятных районов находятся под влиянием техногенных факторов. Вредные химические вещества поступают в организм из воздуха, питьевой воды, продуктов питания и обнаруживаются в ротовой жидкости, твердых тканях зуба, зубных отложениях, биоптатах тканевых структур и способствуют развитию кариеса и воспалительных заболеваний пародонта. Для профилактики основных стоматологических заболеваний применяются зубные пасты и ополаскиватели. В составе зубных паст содержатся различные абразивы: диоксид кремния, карбонат кальция, диоксид титана, гидрокарбонат кальция, гидроксиапатит, которые могут выступать в роли адсорбентов соединений тяжелых металлов. Биомониторинг с использованием метода масс-спектрометрии с индуктивно связанной плазмой (ИСП-МС) позволяет определять микроколичество металлов в ротовой жидкости. Исследование средств индивидуальной гигиены полости рта показали, что зубные пасты и ополаскиватели, применяемые пациентами для профилактики и лечения воспалительных заболеваний пародонта, имеют адсорбционную активность в отношении ионов металлов. В статье проведена оценка адсорбционной эффективности лечебно-профилактической зубной пасты относительно ионов металлов (хрома, марганца, кадмия, свинца и др.) в ротовой жидкости у жителей экологически неблагоприятных районов. Применение адсорбционно эффективной зубной пасты, содержащей оксиды кремния и титана, дважды в день на протяжении двух недель показало достоверное снижение концентрации ионов марганца, хрома, мышьяка, свинца и кадмия в смешанной слюне жителей, которые находятся под влиянием неблагоприятных экологических факторов. Современный метод ИСП-МС целесообразно использовать для высокоточного мониторинга ионного состава ротовой жидкости пациентов, проживающих в экологически неблагоприятных районах.

Ключевые слова: *зубная паста, ополаскиватель для полости рта, адсорбционная эффективность, мониторинг, оксид кремния*

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CLINICAL AND EXPERIMENTAL SUBSTANTIATION OF THE CHOICE OF TOOTHPASTES ON THE BASIS OF MONITORING THE COMPOSITION OF THE ORAL FLUID IN THE INHABITANTS OF INDUSTRIAL AREAS

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Abstract

The inhabitants of industrial areas are influenced by anthropogenic factors. Harmful chemicals enter the body from the air, drinking water, food and are found in the oral fluid, hard tooth tissues, dental deposits, biopsy of tissue structures and contribute to the development of caries and inflammatory periodontal diseases. Toothpastes and mouthwashes are used for prevention of major dental diseases. The toothpastes contain a variety of abrasives: silicon dioxide, calcium carbonate, titanium dioxide, calcium bicarbonate, hydroxyapatite, which can act as adsorbents of heavy metal compounds. Biomonitoring using inductively coupled plasma mass spectrometry (ICP-MS) allows to determine the micro-quantities of metals in blood, urine, human milk, hair and oral fluid. The study of oral hygiene products showed that toothpastes and mouthwashes, used by patients for prevention and treatment of inflammatory periodontal diseases, have an adsorption activity for metal ions. The article evaluates the adsorption efficiency of medical and preventive toothpaste relative to the metal ions (chromium, manganese, cadmium, lead, etc.) in the oral fluid of the inhabitants of industrial areas. The use of adsorption-effective toothpaste twice a day for two weeks showed a significant decrease in the concentration of metal ions in the mixed saliva of the inhabitants which are under the influence of unfavorable environmental factors. When using a toothpaste containing silicon and titanium oxides, the concentration of manganese, chromium, arsenic, lead and cadmium ions in the oral fluid decreases within 2 weeks. The modern method of ISP-MS is advisable to use for high-precision monitoring of the oral fluid ion composition in patients living in the industrial areas.

Keywords: *toothpaste, mouthwash, adsorption efficiency, monitoring, silicon oxide*

Introduction

The incidence and prevalence of dental diseases, such as dental caries and inflammatory periodontal disease are higher in people who are in direct contact with the factors of the industrial environment [1, 2, 6, 7, 13, 19, 20, 25], this indicates the need to improve the system of dental prevention. The inhabitants of industrial cities are also influenced by anthropogenic environmental factors, such as air containing heavy metal ions (lead, cadmium, chromium, arsenic, etc.). Harmful chemicals enter the body from the air, drinking water, food and are found in the oral fluid (OF), hard tooth tissues, dental deposits, biopsy of tissue structures and contribute to the development of caries and inflammatory periodontal diseases [1, 2, 6, 8, 9, 11, 13, 14]. Biomonitoring using inductively coupled plasma mass spectrometry (ICP-MS) allows to determine the micro-quantities of metals in blood, urine, human milk, hair and OF [8—12, 14—18, 21—24]. Monitoring data are used to adjust nutrition, to develop methods of treatment and prevention of diseases associated with the failure of metal-ligand homeostasis [8, 9, 16, 17]. Toothpastes (TP) and mouthwashes are used for prevention of major dental diseases [3—5, 7]. The toothpastes contain a variety of abrasives: silicon dioxide, calcium carbonate, titanium dioxide, calcium bicarbonate, hydroxyapatite, which can act as adsorbents of heavy metal compounds [6, 7]. The problem of choosing the oral hygiene products is relevant in the presence of heavy metal ions in the OF.

The purpose of research is to determine the effect of oral hygiene products on the variation in the concentration of heavy metal ions in the oral fluid in the inhabitants of industrial cities according to the results of monitoring.

Materials and methods of research

Clinical studies were conducted at the Department of Therapeutic Dentistry of the Ural State Medial University and included the analysis of complaints and medical history, visual examination, index assessment of oral hygiene (OHI - S, J.R. Green, J.R. Vermillion, 1969), hard tooth tissues (DMFT), periodontal tissues (PBI, Muhllemann, Saxer, 1965). The clinical study involved 27 somatically safe men, inhabitants of the industrialized city, aged 20 to 23 years, who signed a voluntary informed consent to participate in the study (mean age 21.40±1.59). The OF sampling was carried out in the morning, in the fasted state. Patients were trained in the rules of oral care, provided with medium toothbrushes, TP and mouthwash which are adsorption-effective against heavy metal ions [8, 9]; they brushed their teeth twice a day for two weeks. The laboratory measurements were carried out at the Institute of Geology and Geochemistry of UB RAS

(Shared knowledge center «Geoanalyst», supported by the grant of the President of the Russian Federation for State support of leading schools of thought in the Russian Federation NSH-9723.2016.5). Using the method of ICP-MS according to NSAM №480-X, 46 elements were defined in the composition of the OF: manganese, arsenic, cadmium, lead, chromium. All laboratory measurements were carried out in the mode of quantitative analysis with plotting the calibration curves using multi-element standard solutions Perkin Elmer Instruments, 99.998% argon [8, 9].

Statistical processing of the results was carried out using the application package MS Excel, Vortex 7.0. To compare the data, student's t-test was used; the confidence level was $p \leq 0.05$ [3—6, 8].

Results

According to the clinical examination, the average DMFT was 8.83±2.07. As a result, the use of the suggested oral hygiene products contributed to the improvement of hygiene (reduction of OHI-S level by 52.0±3.5%; $p<0.05$) and to the reduction of the degree of inflammation of periodontal tissues (reduction of PBI index by 58.2±10.1%; $p<0.05$). As a result of the analysis of the OF ion composition, the increased value of chromium content was determined in 18.52% of cases, manganese in 22.22% of cases, arsenic in 7.40% of cases, cadmium in 22.22% of cases, lead in 11.11% of cases. Moreover, 6 persons showed an increased concentration of one metal, and 1 person had an increased concentration of two metals, and in 4 persons there was an increased concentration of three or four metals.

As a result, all patients significantly decreased the content of manganese, arsenic, lead and cadmium in the oral fluid, $p<0.05$ (table 1).

The monitoring of the OF ion composition in the industrial areas allows us to personalize the approach when choosing the oral hygiene products which are adsorption-efficient relative to heavy metal ions present in mixed saliva, Reducing the level of contamination of the OF with heavy metal ions will increase the effectiveness of prevention and treatment of major dental diseases (dental caries and inflammatory periodontal diseases), due to the lack of additional negative effects of ecotoxicants on the organs and tissues of the oral cavity,

Conclusion

1. The modern method of ISP-MS is advisable to use for high-precision monitoring of the OF ion composition in patients living in the industrial areas.
2. When choosing the oral hygiene products for inhabitants of the industrial areas, a personalized approach should be used on the basis of the analysis of the OF ion composition, followed by monitoring of their effectiveness.
3. When using a toothpaste containing silicon and titanium oxides, the concentration of manganese, chromium, arsenic, lead and cadmium ions in the OF decreases within 2 weeks.

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Table 1

The examples of variations in the content of metal ions in the OF before and after (2—5 weeks after) the use of adsorption-effective oral hygiene products

Element		**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	*Element*		**2.1**	**2.2**	**2.3**	**2.4**
Mn	µg/l	125.84	11.99	70.69	75.25	10.07	Cd	µg/l	4.19	0.3	<0.1	<0.1
		2.1	**2.2**	**2.3**	**2.4**				**3.3**	**3.1**	**3.2**	
Pb	µg/l	32.99	0.68	1.01	<0.2			µg/l	7.81	<0.1	<0.1	
		3.1	**3.2**	**3.3**					**6.1**	**6.2**	**6.3**	**6.4**
Mn	µg/l	296.46	82.89	53.32				µg/l	1.45	0.31	<0.1	<0.1
Pb		156.03	4.16	12.12					**7.1**	**7.2**	**7.3**	
		4.1	**4.2**	**4.3**				µg/l	<0.1	4.58	2.99	
Mn	µg/l	281.98	126.44	72.6					**8.1**	**8.2**	**8.3**	
		5.1	**5.2**	**5.3**				µg/l	9.1	2.21	<0.1	
Mn	µg/l	45.87	115.22	57.07			As	µg/l	46.7	36.55	5.08	
		8.1	**8.2**	**8.3**								
Pb	µg/l	240.79	41.42	6.94								
		9.1	**9.2**	**9.3**	**9.4**							
Mn	µg/l	280.23	28.87	70.24	60.53							

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