

The role of middle-weight molecules and the detoxication activity of mixed saliva albumin in the development of periodontal pathology in oil refinery workers

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Abstract. The study evaluated the biochemical effects of chronic exposure to the oil refining industry on medium-weight molecules and the detoxifying activity of mixed saliva albumin in the development of periodontal pathology in oil refinery workers in the mixed saliva of workers in hazardous production. The workers of the main specialties of the Bukhara oil refinery were examined.

1 Introduction

According to WHO, 98% of the adult population of the planet have problems associated with the pathology of periodontal tissues. Over the years, there has been a trend towards an earlier onset of this disease and its aggressive course [1-14]. The occurrence and course of periodontitis is aggravated by exposure to harmful factors of the working environment and bad habits [2,6].

The development of periodontitis is accompanied by oxidative stress, which is characterized by an increase in the intensity of lipid peroxidation (LPO), which leads to impaired lipid metabolism, destruction of cell membranes and impaired metabolism in the oral cavity and the development of endogenous intoxication [10,15-27].

Endogenous intoxication is an excessive accumulation of endogenous toxic products in the body [10,17]. Currently, studies of indicators of endogenous intoxication are widely used in the assessment of nonspecific toxic effects, since markers are able to reflect the objective level of toxicity of a particular environment, regardless of the etiopathogenetic features of the disease [12,26]. They are used to assess the impact of harmful production factors on the severity of dental pathology in workers in hazardous industries [2,28].

Among the criteria for endogenous intoxication, special attention is paid to molecules of average mass [9, 19]. Serum albumin (SA) is the most abundant protein in plasma and mixed saliva, and its function is important for maintaining the body's homeostatic balance. SA affects the pharmacokinetics of many drugs, provides metabolic modification of some ligands that render potential toxins harmless, accounts for the majority of the antioxidant capacity of human plasma, and also exhibits esterase and peroxidase enzymatic activities.

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SA exhibits antioxidant properties and is critical for deoxidation from toxic agents and for prodrug activation.

In this regard, the purpose of this study was to assess the level of MSM and the detoxification activity of mixed saliva albumin in workers of the harmful production of the Bukhara oil refinery.

2 Material and research methods

The workers of the main specialties of the Bukhara oil refinery, who agreed to participate in the study, were examined. Ethical clearance was obtained prior to the start of the study.

The assessment of the periodontal condition was carried out on a homogeneous sample of workers in hazardous production with work experience in hazardous working conditions for at least 10 years and a sample of factory management workers comparable in terms of age and sex structure, not in contact with industrial hazards. 64 workers were examined, the control group consisted of 37 employees of the plant management.

Table 1. Characteristics of comparison groups

Index	Gradation	Examined people			
		Workers of hazardous workshops, n = 64		Factory management employees, n = 37	
		ABS	%	ABS	%
Age	18 - 24	7	10,94	4	11,08
	25 - 34	12	18,75	7	18,92
	35 - 44	12	18,75	7	18,92
	45 - 54	19	29,69	11	29,73
	More than 55	14	21,87	8	21,62
	Total	61	100	37	100%
Education	The initial	36	56,25	4	10,81
	The average special	22	34,38	12	32,43
	Higher	6	9,37	21	36,76
Oral hygiene, teeth cleaning	ones	57	89,06	20	54,05
	twice	7	10,94	17	45,05

Demographics included age, location and length of service, and hygiene practices. In the presence of a bad habit of smoking and taking alcoholic beverages, the subjects were excluded from the sample. The comparison groups were homogeneous, which made it possible to compare the results of the study. Examination of the oral cavity was carried out in daylight and, if necessary, an additional source of artificial light was used, using oral mirrors. The severity of periodontal disease was judged by CPI - index in accordance with the WHO recommendations "Examinations of oral health: basic methods - 5th edition, 2013"[16].

Mixed saliva was collected in the morning on an empty stomach by spitting into graduated tubes. The binding capacity of albumin (CCA) was determined using the "Probe-albumin" kit by the fluorescence method on the analyzer AKL-01. The total (OKA) and effective (ECA) concentrations of albumin were determined, as well as the binding capacity of albumin (CCA) and the toxicity index (TI).

Molecules of medium mass (MSM) in mixed saliva were analyzed by the method of Gabrielyan N.I. 1984. Evaluated the content of the nuclear E230, toxic E254 and aromatic E280 fractions with the calculation of the aromaticity index IA (E280/254) and the nuclear peptide index NPI (E230/E254).

Data were collected, tabulated and subjected to descriptive-statistical analysis using the SPSS package (version 21.0).

3 Results of the study

The level of endotoxiosis in the blood of the examined was determined by the content of hydrophilic and hydrophobic products in the mixed saliva. Molecules of medium mass, related to hydrophobic products, are the main marker of endogenous intoxication. They are formed as a result of enhanced proteolysis due to high functional activity and are able to have an alternative effect on the body[22]

The level of endogenous intoxication of mixed saliva was assessed depending on the severity of the destructive periodontal lesion in the comparison groups (values of the CPI index codes). It should be noted that in the comparison groups there were all levels of the CPI index codes. The level of MSM content was determined by the severity of periodontal pathology and the range of studied MSM. As can be seen from the table, the level of the aromatic fraction, determined at a wavelength of E280, did not depend on the severity of periodontal damage and contact with occupational hazards, while both in hazardous production workers and in the comparison group, their concentration did not have significant fluctuations ($P \geq 0.05$).

Table 2. The content of molecules of average molecular weight (MSM) in the mixed saliva of workers in hazardous shops and employees of the plant management ($M \pm m$)

Index	Explored	Codes CPI- Index			Total in the factory	
		0	1-2	3-4		
Mem in the unit.	E280	Workers in hazardous production	0,296• ± 0,01	0,250• ± 0,007	0,248• ^x ± 0,005	0,252• ± 0,01
		Employees of factory management	254 ± 0,05	0,249 ^x ± 0,01	0,251 ^x ± 0,01	0,243 ^x ± 0,01
	E254	Workers in hazardous production	0,252• ± 0,007	0,288• ^x ± 0,01	0,362• ^x ± 0,01	0,341• ± 0,02
		Employees of factory management	0,200 ± 0,005	0,220 ± 0,007	0,254 ± 0,009	0,242 ± 0,01
	E230	Workers in hazardous production	0,12• ± 0,06	0,17• ^x ± 0,008	0,211• ^x ± 0,01	0,176• ± 0,009

		Employees of factory management	0,09 ± 0,04	0,12 ± 0,006	0,150 ± 0,007	0,121 ± 0,005
Indices	Нпи	Workers of hazardous production	0,291• ± 0,01	0,345• ^X ± 0,01	0,421• ^X ± 0,02	0,362• ± 0,01
		Employees of factory management	0,200 ± 0,007	0,240 ± 0,01	0,310 ± 0,01	0,260 ± 0,009
	AndA	Workers of hazardous production	0,71• ± 0,035	0,60• ^X ± 0,03	0,55• ^X ± 0,02	0,602• ± 0,03
		Employees of factory management	1,01 ± 0,005	0,902 ^X ± 0,04	0,80 ^X ± 0,03	0,952 ± 0,04

- P<0.05 in relation to employees of the plant management;
 X - P<0.05 in relation to CPI - 0; ^ - P<0.05 in relation to CPI 1-2.

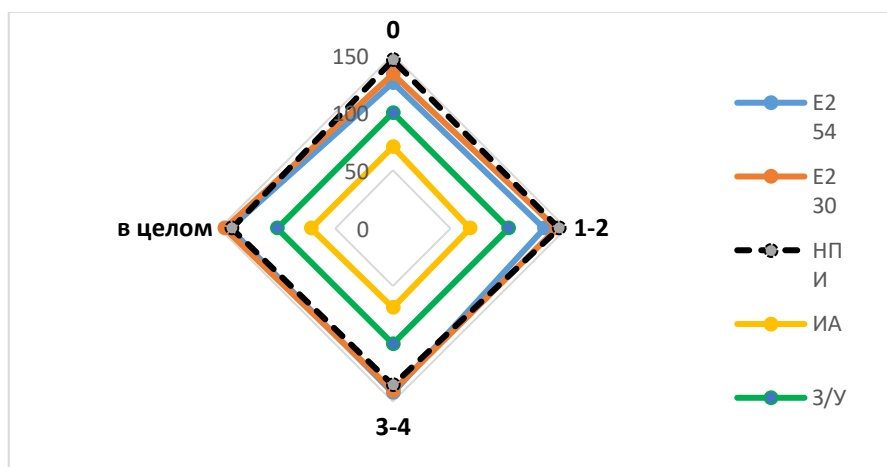


Fig. 1. Dynamics of molecules of average molecular weight (MSM) in the mixed saliva of workers in hazardous shops (in % in relation to employees of the plant management) (CPI codes - index: 0, 1-2; 3-;)

The concentrations of toxic E254 and nuclear E230 fractions were determined by the severity of periodontal disease and working conditions. The most pronounced shifts were found in the content of the toxic fraction MSM E254 and nuclear E230. The concentration of MSM fraction E254 significantly ($P \leq 0.05$) increased synchronously with the increase in index CPI codes both among workers of hazardous workshops and employees of the plant management. What reflects the process of destructive-inflammatory lesions of periodontal tissues. However, regardless of the severity of periodontal disease, the level of MSM E254 of mixed saliva in workers significantly ($P \leq 0.05$) exceeded the indicators of the plant management. So, even in those examined with healthy periodontium (CPI code - 0), the

level of MSM E254 in workers was higher than the control by 26.00% ($P \leq 0.05$); code CPI - 1-2 - by 30.91% ($P \leq 0.05$) and with code CPI - 3-4 - by 42.52% ($P \leq 0.05$); in general, among workers, the level of MSM E254 of mixed saliva exceeded the plant management by 40.91% ($P \leq 0.05$); the corresponding dynamics of the nuclear E230 fraction was 33.33% ($P \leq 0.01$); 41.67% ($P \leq 0.01$); 40.76% ($P \leq 0.01$) and 45.45% ($P \leq 0.01$) (Table 1 and Figure 1). The accumulation of toxic products in the oral fluid of workers in hazardous industries is evidenced by an increase in the nuclear peptide index (NPI) and a decrease in the aromaticity index. So, with a healthy periodontium (CPI code - O), the NPI index among workers was 45.50% higher than the control ($P \leq 0.05$); code CPI - 1-2 - by 43.75% ($P \leq 0.05$) and with code CPI - 3-4 - by 35.81% ($P \leq 0.05$); in general, among the workers, the value of the NPI of the index of mixed saliva exceeded the plant management by 39.23% ($P \leq 0.05$); the corresponding dynamics of the decrease in the IA index was 29.60% ($P \leq 0.01$); 33.37% ($P \leq 0.01$); 31.25% ($P \leq 0.01$) and 29.31% ($P \leq 0.01$) (Table and Figure 1).

Endogenous intoxication not only accompanies most diseases, but is an important factor in their pathogenesis, and also determines possible side effects in cases, because an important feature of MSM is their high biological activity. They have neurotoxic activity, inhibit protein synthesis, promote hemolysis of erythrocytes, inhibit erythropoiesis and enzyme activity, and cause a state of secondary immunosuppression [25].

Molecules of medium molecular weight are markers of endotoxigenesis, a sharp increase in their content indicates the development and generalization of endogenous intoxications.

Thus, the accumulation of toxic products is recorded in the oral fluid of workers in harmful production of an oil refinery, reflecting not only local, but also systemic toxic effects of harmful production. The syndrome of endogenous intoxication is accompanied by increased tissue breakdown, increased catabolic processes as a result of the accumulation of an excess amount of biologically active substances, deformed protein metabolites and other toxic substances of endogenous origin [24]. This explains the increased level of endogenous intoxication of the mixed saliva of blood workers in comparison with employees of the plant management who were not exposed to industrial hazards. It is obvious that the formation of endogenous intoxication syndrome in workers of hazardous industries is an important link in the pathogenesis of systemic pathology and periodontal diseases.

Albumin is a multifunctional protein with antioxidant, immunomodulating and detoxifying functions. It is known that human albumin binds a wide range of endogenous and exogenous substances [13].

Table 3. Detoxification activity of albumin in mixed saliva of workers in hazardous shops and employees of the plant management ($M \pm m$)

Showптели	Обследованные	Index Codes CPI			Total in the factory
		0	1-2	3-4	
OKA g/l	Workers in hazardous production	1,62 • ± 0,07	1,25 • ^x ± 0,06	0,66 • ^x ± 0,03	1,02 • ± 1,67
	Employees of factory management	2,11 ± 0,09	1,87 ^x ± 0,08	1,25 ± 0,06	1,67 ± 0,07
EKA g / l	Workers in hazardous production	1,25 • ± 0,06	1,05 • ^x ± 0,04	0,79 • ^x ± 0,03	1,02 • ± 0,05
	Employees of	1,53	1,31 ^x	1,02 ^x	1,38

	factory management	$\pm 0,06$	$\pm 0,05$	$\pm 0,04$	$\pm 0,06$
SSA,%	Workers in hazardous production	73,25 • $\pm 2,65$	57,82 • ^x $\pm 2,32$	42,51 • $\pm 2,6$	52,01 • $\pm 2,42$
	Employees of factory management	93,25 $\pm 4,21$	77,32 ^x $\pm 3,01$	61,41 ^x $\pm 2,77$	72,11 $\pm 3,25$
IT U.E.	Workers in hazardous production	0,93 • $\pm 0,04$	1,21 • ^x $\pm 0,05$	1,32 • ^x $\pm 0,06$	0,92 • $\pm 0,04$
	Employees of factory management	0,70 $\pm 0,03$	0,92 ^x $\pm 0,04$	0,07 ^x $\pm 0,05$	0,73 $\pm 0,03$

• - $P < 0.05$ in relation to the employees of factory management;

^x- $P < 0.05$ in relation to CPI - 0; - $P < 0.05$ in relation to CPI 1-2

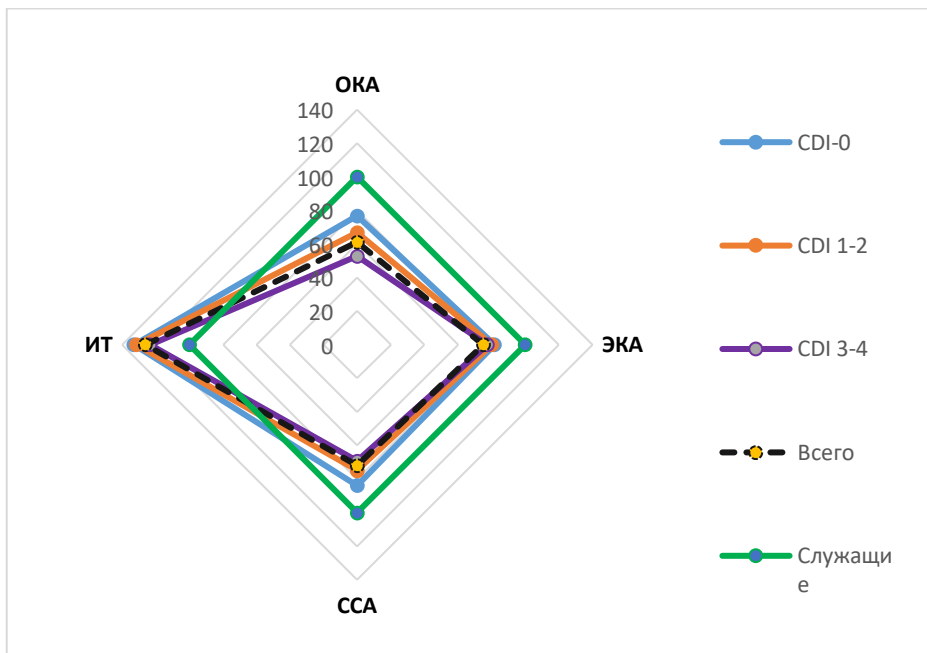


Fig. 2. Dynamics of detoxification activity of albumin in the mixed saliva of workers in hazardous shops (in % in relation to employees of the plant management).

Conditions of endogenous intoxication in workers of harmful workshops revealed a decrease in the binding capacity of albumin of mixed saliva. The decrease in the functional activity of albumin in both comparison groups is associated with the severity of local periodontal damage, which reflects its role in the inactivation of toxins and decomposition products of periodontal tissues [6,11,23]. However, the level of decrease in albumin activity is higher among workers in hazardous production. So, even in the absence of inflammatory-destructive lesions of the periodontium (code CPI - O), the total albumin concentration (OKA) of mixed saliva albumin in workers was lower than the corresponding

indicator of plant management by 23.23%; with the code value CPI - 1-2 - by 33.16% ($P \leq 0.05$) and with the code level CPI - 3-4 - by 49.20% ($P \leq 0.01$); in general, the albumin content of the mixed saliva of the fluid in the OCA workers is lower than the plant management by 40.91% ($P \leq 0.01$); the corresponding dynamics of the effective concentration of albumin (ECA) was 33.33% ($P \leq 0.01$); 41.67% ($P \leq 0.01$); 40.76% ($P \leq 0.01$) and 45.45% ($P \leq 0.01$); sorption capacity of albumin (SSA) by 16.09%, respectively ($P \leq 0.05$); 25.22% ($P \leq 0.05$); 30.79% ($P \leq 0.01$) and 28.18% ($P \leq 0.05$); at the same time, the toxicity index (IT) increases by 32.86% ($P \leq 0.01$); 31.53% ($P \leq 0.01$); 23.36% ($P \leq 0.05$) and 26.03% ($P \leq 0.05$) (Table 3 and Figure 2).

The aim of the study was to search for patterns in the change in indicators of endogenous intoxication and the sorption capacity of mixed saliva albumin in oil refinery workers and persons not in contact with occupational hazards in order to establish the role of occupational hazards in the pathogenesis of periodontitis, diagnosis and prognosis of the course of the disease.

The increase in endogenous intoxication of the body plays a decisive role in the pathogenesis of periodontal diseases, as it leads to toxic damage to cell membranes and aggravation of the syndrome of endogenous intoxication in the oral cavity, causing damage to healthy tissues and contributing to the progression of destruction of the periodontal ligament [8]. It is important to comprehensively evaluate the processes of endotoxemia for individual fractions of medium molecular toxins, which characterize catabolic processes and the level of albumin binding capacity, which characterizes the activity of the body's detoxification systems.

For additional information, individual fractions of medium molecular weight toxins were evaluated, the nuclear peptide index NPI (E230/E254) and the aromaticity index IA (E230/E254) were calculated.

Nuclear-peptide index NPI (E230/E254) is an integrative indicator of catabolic reactions and autointoxication of the body. In the absence of exposure to toxic industrial hazards, its value is 0.200 units, and workers in hazardous industries increase to 0.291 units; with periodontal pathology (CPI - 1-2), the NPI index among workers increases to 0.345 units against 0.240 units with a similar condition of the periodontium in non-contacting workers of the plant management; and reaches 0.421 units against 0.3190 in severe periodontitis (CPI - 3-4).

In general, the NPI value for workers is 0.362 units against 0.260 units in surveyed workers working in safe working conditions.

MSM are able to block cell receptors by binding to the active centers of the albumin molecule, competing with regulatory peptides and thereby disrupting the process of humoral regulation [5, 18]. This determined the need to assess the detoxification function of mixed saliva albumin. Surveys have shown a decrease in the detoxification abilities of mixed saliva albumin in workers in hazardous production conditions. In the surveyed workers of harmful production with healthy periodontium, the effective concentration of albumin (ECA) is already lowered to 1.25 g/l versus 1.53 g/l in employees of the plant management who are not in contact with industrial hazards; with periodontal pathology (CPI - 1-2), ECA in workers decreases to 1.05 g/l versus 1.31 g/l in workers of the plant management who are not in contact with hazards; and decreases to 0.79 g/l against 1.02 g/l in severe periodontitis (CPI - 3-4). In general, the value of ECA in workers is 1.02 g/l versus 1.38 g/l in those surveyed, working in safe working conditions; the corresponding ratios of the sorption capacity of albumin (SSA) were 78.25% versus 93.25%; 57.82% vs. 77.32%; 42.50% versus 61.41% and 52.01% versus 72.11% and an increase in the toxicity index (IT), respectively, 0.93 c.u. against 0.70 c.u.; 1.121 against 0.92 c.u.; 1.32 c.u. against 1.07 c.u. and 0.92 c.u. against 0.73 c.u.

The results of biochemical studies of mixed saliva showed that at all stages of the development of the pathological process in the periodontium, there is a consistent increase in the level of endogenous intoxication and a decrease in the sorption capacity of mixed saliva albumin. These shifts are obviously the result of insufficient elimination of toxic industrial hazards in the conditions of their chronic impact on the body of workers [18, 23].

4 Conclusion

Both in healthy periodontium and at all levels of periodontal lesions, changes are significantly more significant in workers in contact with industrial hazards of an oil refinery. The inflammatory process in periodontal tissues in conditions of harmful production is steadily progressing.

Thus, the constant impact of working environment factors that have a negative impact on the body of workers can change the host's response to processes in the periodontium, increasing susceptibility to periodontal diseases, and the course and progression of the disease can become more aggressive [4].

Quantitative changes in the content of MCM and the detoxifying ability of albumin in mixed saliva in hazardous production workers can affect the risk of occurrence, severity and progression of periodontal diseases and, consequently, the specifics of disease therapy.

The data obtained can be used to develop tools for diagnosing and predicting the course of the disease, as well as to monitor the effectiveness of therapy.

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