Levels of pro-inflammatory cytokines and markers of oxidative stress in mixed saliva of Bukhara oil refinery workers

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Abstract. The study evaluated the biochemical effects of chronic exposure to the oil refining industry on the levels of pro-inflammatory cytokines and lipid peroxidation processes in the saliva of hazardous production workers. The workers of the main specialties of the Bukhara oil refinery were examined. The levels of pro-inflammatory cytokines both in the workers of the hazardous shops of the oil refinery and in the employees of the plant management were determined by the amount of destruction of the epithelial attachment of the gums, determined by the value of the CPI index. At the same time, with an increase in the severity of periodontal lesions, the concentrations of pro-inflammatory mediator significantly increased (P ≤ 0.05). In those examined with healthy periodontium (CPI 0), the concentration of TNF-α in the mixed saliva of workers in hazardous production exceeds that of employees of the plant management by 83.85% (P ≤ 0.01); in those examined with low values of the CPI index (1–2), this excess was 41.23% (P ≤ 0.01) and in severe lesions (CPI 3–4) – 72.23% (P ≤ 0.01). In general, the concentration of TNF-α in the mixed saliva of workers at the enterprise exceeded that of employees of the plant management by 61.20% (P ≤ 0.01); the corresponding excess levels of IL-6 were 85.00%; 80.00%; 72.33% and 65.91%.

1 Introduction

The oil refining industry is one of the most toxic types of industrial production, causing damage to many organs and body systems. Refinery workers are exposed to toxic fumes of hydrogen sulfide and sulfur dioxide while on the job. In addition to these chemical fumes, refineries can generate a variety of air pollutants, including particulate matter, carbon monoxide, and volatile organic compounds. Closed workshops contribute to the accumulation of toxic gases. Thus, the oil refining industry causes multiple systemic damage (neurological, renal and cardiovascular) in people exposed to it for a long time [1-5, 11, 16].

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Few studies have established the negative impact of this production on the organs and tissues of the oral cavity. The exact mechanism of the toxicity of oil refineries operating under harmful conditions has not yet been fully elucidated, but one of the main proposed mechanisms is oxidative stress, characterized by an increase in the number of reactive oxygen species, which, in turn, interact and damage molecules such as DNA, proteins and lipids, which leads to damage to organs and systems [6-8, 17].

Over the past twenty years, saliva research has shown that it is an alternative diagnostic fluid for diagnosing local or systemic diseases, and research in this area is a major medical priority of the 21st century [2].

Based on this, the aim of this study was to evaluate the biochemical effects of chronic exposure to the oil refining industry on the levels of pro-inflammatory cytokines and lipid peroxidation processes in the saliva of hazardous production workers.

2 Material and methods of research

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 studies were carried out on a homogeneous sample of workers in hazardous production with at least 10 years of work experience in hazardous working conditions and a sample of plant management workers comparable in terms of sex and age structure, not in contact with industrial hazards. Mixed saliva was collected in the morning on an empty stomach by spitting into sterile graduated test tubes. 31 workers and 20 employees of the plant management, comparable in age and social and living conditions were examined and made up the control group.

Levels of interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α) were determined using enzyme-linked enzyme immunoassay (ELISA). The total antioxidant activity was evaluated according to Kondrakhin I.P. 2004; the MDA level was assessed using the colorimetric method (Stalnaya I.D., Garishvili T.G., 1977).

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

3 Results

Mixed saliva is a mirror of the health of the body and has great potential to be used in place of a blood test [2]. Saliva contains a wide variety of proteins, peptides, nucleic acids, hormones, and electrolytes from various sources. The presence of biological molecules in saliva reflects their connection with the presence of pathology, and therefore mixed saliva is used as a diagnostic fluid [2-9]. Changes in human health can be reflected through the oral mucosa [9]. In this connection, we assessed the level of pro-inflammatory cytokines.

IL-6 is a multifunctional cytokine that plays a role in the regulation of the hematopoietic system and the tension and activity of the immune system, is produced in response to tissue damage and infection [1, 19-12]. Several cell types are associated with the production of this cytokine, including fibroblasts, keratinocytes, contractile cells, vascular endothelial cells, mast cells, macrophages, dendritic cells, and T and B cells [3, 12]. TNF-α is mainly synthesized in mononuclear macrophages after inflammatory stimulation and has many physiological functions, especially in inflammation and immune response.

Table 1. Levels of pro-inflammatory cytokines TNF-α, IL-6 in mixed saliva of comparison groups at different values of the CPI index

<table>
<thead>
<tr>
<th>CPI Index</th>
<th>TNF-α</th>
<th>IL-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>123</td>
<td>456</td>
</tr>
<tr>
<td>2</td>
<td>345</td>
<td>678</td>
</tr>
<tr>
<td>3</td>
<td>567</td>
<td>890</td>
</tr>
</tbody>
</table>
As can be seen from the data presented in Table 1, the levels of pro-inflammatory cytokines both in the workers of the hazardous shops of the oil refinery and in the employees of the plant management were determined by the amount of destruction of the epithelial attachment of the gum, determined by the value of the CPI index. At the same time, with an increase in the severity of periodontal lesions, the concentrations of pro-inflammatory mediators significantly increased (P ≤ 0.05) (Table 1). The most interesting information was obtained from a comparative assessment of the concentrations of the studied markers in the mixed saliva of workers in hazardous production and employees of the plant management with identical values of the CPI index (Figure 1).

So, even in those examined with healthy periodontal (CPI = 0), the concentration of TNF-α in the mixed saliva of workers in hazardous production exceeds that of employees of the plant management by 83.85% (P ≤ 0.01); in those examined with low values of CPI
CPI index (1–2), this excess was 41.23% (P ≤ 0.01) and in severe lesions (СР I–II) 72.23% (P ≤ 0.01). In general, the concentration of TNF-α in the mixed saliva of workers at the enterprise exceeded that of employees of the plant management by 61.20% (P ≤ 0.01); the corresponding excess levels of IL-6 were 85.00%; 80.00% 72.33% and 65.91% (Figure 1).

Many studies report on the cytokine network involved in periodontitis and its decisive influence on the recruitment of specific monocytes, the control of pathobionts, and the induction or suppression of osteoclast activity [10]. However, the specifics of pathogen stimulation in the oral cavity that lead to a specific and complex periodontal cytokine network are far from being elucidated. Thus, in petrochemical workers, the development of periodontal diseases occurs against the background of overexpression of pro-inflammatory cytokines. This significantly exacerbates the destructive processes that are implemented as part of the host’s inflammatory response and lead to a more pronounced destruction of hard and soft periodontal tissues.

### Table 2.

<table>
<thead>
<tr>
<th>CPI Code</th>
<th>CPI Value</th>
<th>AOA Value</th>
<th>MDA Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2</td>
<td>0.92±0.04</td>
<td>1.33±0.05</td>
<td>0.93±0.04</td>
</tr>
<tr>
<td>3–4</td>
<td>0.92±0.04</td>
<td>1.33±0.05</td>
<td>0.93±0.04</td>
</tr>
</tbody>
</table>

* • - District <0.05 with respect to the servant of the planting;  
  Х - District <0.05 with respect to CPI-0;  
  - P <0.05 with respect to CPI-1;  
  - P <0.05 in relation to CPI-3–4.

**Fig. 2.** Dynamics of AOA activity and MDA levels in mixed saliva of workers of harmful production (in % with respect to the servant of the planting).
and developing the pathology of inflammatory diseases of the OSA cavity [8]. The anti-oxidants of saliva are the first line of protection against oxidative stress caused by free radicals [8].

Free radicals, active forms of oxygen and antioxidant systems interact with each other, while antioxidants act in a single system, rather than affixing. Therefore, individual studies of antioxidant activity can be misleading, and the size of a separate antioxidant may be less indicative for the general situation of the state of the antioxidant organism system. The present study estimates the overall antioxidant activity of mixed saliva (AOA) [9]. It was found that the activity of the antioxidant system of mixed saliva in the workers of harmful production is reliably lower (p ≤ 0.05) of the corresponding activity of the servants of the planting (Table 3). This trend was detected independently of the severity of the periodontal. Used with a healthy periodontal (CP = 0) activity of AOA in mixed saliva of workers of harmful production exceeded the servants of the coatings by 76.00% (p ≤ 0.01); At low levels of periodontal defeat (CP = 1-2) this exceeded was 64.17% (p ≤ 0.01) and with severe defeat (CP = 3-4) 69.17% (p ≤ 0.01) [12].

MDA is the final product of the peroxide oxidation of lipids. Its content reflects the degree of peroxidation of lipids in the body, which indirectly indicates the level of cell damage. Analysis of the results of the studies showed that the levels of the MDA of the mixed saliva of the workers have significantly exceeded the same indicators of the coatings: with CP = 0 to 54.05% (p ≤ 0.01); with CP 1-2 by 59.62% (p ≤ 0.01); With CP 3-4 60.22% (p ≤ 0.01) and in general, by the plant by 52.87% (p ≤ 0.01) (Figure 2). Analysis of MDA proves the influence of harmfulness of the oil refinery to the risk of the occurrence and severity of the flow rate of the periodontal [14].

4 Discussion

Periodontal disease is one of the common and underlying diseases that can lead to chronic inflammation, destruction of dental support structures, and tooth loss in adults [14]. Epidemiological studies have established the features of the course of the disease in industrial workers with a variety of industrial hazards [4, 11, 13]. Such studies provide important information about the characteristics of the frequency and clinical course of pathology, depending on the nature of industrial hazards, and are the material basis for planning and implementing pathogenetically oriented therapeutic and preventive measures.

In-depth studies of the pathogenetic mechanisms of the development of periodontal pathology in conjunction with the specific hazards of production are important for practical health care, and contribute to the resolution of many medical problems. The existing factual material of periodontal pathology in various production conditions ambiguously defines them as an important factor in the progression of pathology [4, 5, 11]. Despite the significant variability in the prevalence and severity of periodontal pathology in different populations and its dependence on living conditions, socioeconomic factors, and background pathology, within the existing population variations, periodontal epidemiology is determined by the conditions in which patients with periodontitis are located [14]. A pronounced increase in the concentration of pro-inflammatory cytokines and an imbalance of LPO-AOS processes in workers in hazardous industries reflects the impact of occupational hazards on the mechanisms of pathology development in this contingent [1, 5].

Thus, the industrial hazards of an oil refinery are a systemic risk factor for the development of periodontitis. The results obtained can become the basis of special preventive programs and guide public health authorities in their development.
References


10. F. C. Carvalho, M. R. Godinho, A. P. Ferreira, Cardiovascular risk factors among oil refinery workers: ecological study, Fatores de risco cardiovascular em trabalhadores de uma refinaria de petroleo e derivados: um estudo ecologico, Revista Brasileira de Medicina do Trabalho, 18, 1 (2020)


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