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ABSTRACT

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FEATURES OF OXIDATIVE PROCESSES DISORDERS IN BACTERIAL-IMMUNE PERIODONTITIS ON THE BACKGROUND OF THE USE OF PROSTHETIC BASES

Introduction. In response to the use of dentures, chronic pathological processes of the mucous membrane, which serves as an entrance gate for microorganisms and denture components, may develop; as a result, lipid peroxidation processes and a decrease in the activity of antioxidant protection are observed. The purpose of this study was to examine the alterations in oxidative processes and the buildup of peroxidation products in rats with experimentally induced bacterial-immune periodontitis while utilizing removable dentures with acrylic and nylon bases.

Methods. Experimental periodontitis was modelled in experimental animals by injecting into the periodontal tissues a suspension containing a mixture of microorganisms (Staphylococcus aureus and Streptococcus hemolyticus) based on egg white. Biochemical analysis of the activity of free radical processes (oxygen and nitrogen) in blood serum was performed, namely diene conjugates, triene conjugates, products of oxidative modification of proteins (neutral and basic), TBA-active products, and the level of nitrogen (II) oxide metabolites on the 30th day of the investigation both without and with different types of removable denture bases fixed in the oral cavity of experimental animals.

Results. Throughout the study, it was determined that by the 30th day of the experiment, the inflammatory process in the periodontal complex led to a notable rise in lipoperoxidation products within the blood serum. This was evidenced by elevated levels of diene and triene conjugates, TBA-active compounds, and oxidatively modified protein products. Analysis of changes in lipoperoxidation indicators in the blood serum of experimental animals with inflammation and different types of prosthetic bases shows that the level of reactive oxygen species increased compared to the control group. However, the indicators were lower than in animals without the use of bases, which indicates the

preservation of free radical processes and a violation of the dynamic balance between oxidative stress and antioxidant protection.

Conclusion. Inflammation in the periodontal complex, driven by bacterial-immune factors, is characterized by heightened oxidative stress, homeostatic imbalance, and accelerated production of lipoperoxidation products. The use of acrylic and nylon bases leads to a decrease in the concentration of peroxidation products, but inflammatory activity remains.

Keywords: periodontitis, oxidative processes, lipid peroxidation, oxidative stress, removable prosthetics, periodontium, base materials, nylon prosthesis, acrylic prosthesis.

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ОСОБЛИВОСТІ ПОРУШЕНЬ ОКСИДАЦІЙНИХ ПРОЦЕСІВ ПРИ БАКТЕРІАЛЬНО-ІМУННОМУ ПАРОДОНТИТІ НА ТЛІ ВИКОРИСТАННЯ ПРОТЕЗНИХ БАЗИСІВ

Вступ. У відповідь на використання протезів можуть розвиватися хронічні патологічні процеси слизової оболонки, яка слугує вхідними воротами для мікроорганізмів і компонентів протезів, в наслідок чого спостерігаються процеси перекисного окислення ліпідів та зниження активності антиоксидантного захисту. Метою роботи було дослідити порушення оксидаційних процесів та накопичення продуктів пероксидації у щурів при експериментальному бактеріально-імунному пародонтиті за умов використання акрилових та нейлонових базисів знімних зубних протезів.

Методи. У піддослідних тварин експериментальний пародонтит моделювали шляхом ін'єкційного введення в тканини пародонта суспензії, що містила суміш мікроорганізмів (Staphylococcus aureus і Streptococcus hemolyticus) на основі яєчного білка. Проводили біохімічний аналіз активності вільнорадикальних процесів (кисневих та азотних) у сироватці крові, а саме дієнових кон'югатів, трієнових кон'югатів, продуктів окисної модифікації білків (нейтрального та основного характеру), ТБК-активних продуктів, рівню метаболітів нітрогену (II) оксиду на 30-й день експерименту як без, так і з зафіксованими в ротовій порожнині піддослідних тварин різних типів базисів знімних зубних протезів.

Результати та їх обговорення. Під час досліджень виявлено, що на 30-ту добу експерименту із запальним процесом у пародонтальному комплексі у сироватці крові спостерігалося значне збільшення продуктів ліпопероксидації. Це підтверджувалося підвищенням концентрації дієнових кон'югатів та трієнових кон'югатів, ТБК-активних продуктів та продуктів окиснювальної модифікації білків. Аналіз змін показників ліпопероксидації у сироватці крові експериментальних тварин із запаленням та різними типами протезних базисів показує, що рівень активних форм кисню підвищився порівняно з контрольною групою. Однак, показники були нижчим ніж у тварин без використання базисів, що свідчить про збереження вільнорадикальних процесів і порушення динамічної рівноваги між оксидативним стресом та антиоксидантним захистом.

Висновок. Розвиток запального процесу в пародонтальному комплексі з бактеріально-імунним компонентом супроводжується активним окислювальним стресом, порушенням гомеостазу та інтенсивним утворенням продуктів ліпопероксидації. Використання акрилових і нейлонових базисів призводить до зниження концентрації продуктів пероксидації, проте залишається запальна активність.

Ключові слова: пародонтит, оксидаційні процеси, пероксидне окиснення ліпідів, окислювальний стрес, знімне протезування, пародонт, базисні матеріали, нейлоновий протез, акриловий протез.

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ABBREVIATIONS

LPO – lipid peroxidation
DC – diene conjugates
TC – triene conjugates
OMP – oxidative modification of proteins
TBA-AP – thiobarbituric acid-active products

INTRODUCTION

In prosthetic dentistry, the impact of dentures on oral tissues is a significant concern. The focus lies on both the direct impact of orthopedic structures composed of various materials on the oral cavity's homeostasis and the opposite effect, where disruptions in homeostasis influence the adaptation process to dental prosthetics [1]. Acrylic plastics are susceptible to biological degradation within the oral cavity, and the resulting decomposition products can alter factors of both specific and nonspecific immunity, leading to a suppression of local immune responses [2, 3]. The use of dentures can trigger the development of chronic pathological processes in the mucous membrane, which acts as a gateway for microorganisms and denture components [4]. Increased lipid peroxidation and reduced antioxidant activity play a crucial role in the development of denture stomatitis [5]. The mucosal response to removable dentures is also influenced by the individual's reactivity and the presence of underlying conditions [6].

Inflammatory processes in the periodontal complex are among the most prevalent diseases in the maxillofacial region [7]. Alterations in oxidative processes are crucial to the pathogenesis of these conditions, serving as triggering factors alongside pathogenic microorganisms, especially associations of *Staphylococcus aureus* and *Streptococcus*. These microorganisms thrive when the resistance of oral tissues to infections is diminished [8]. Lipid peroxidation activation represents a fundamental mechanism in stress-induced damage, disrupting cellular metabolism mainly through harm to cellular and subcellular membranes [9].

During treatment with removable dentures, proteins in oral fluids undergo oxidative modifications, leading to reduced antioxidant activity in saliva and heightened lipid peroxidation [10]. Patients also exhibit increased levels of free radical lipid oxidation in both blood and oral fluids, along with alterations in the activity of enzymes responsible for antioxidant defense [11].

The purpose of this study was to examine the alterations in oxidative processes and the buildup of peroxidation products in rats with experimentally induced bacterial-immune periodontitis while utilizing removable dentures with acrylic and nylon bases.

MATERIAL AND METHODS

The experiments were carried out on clinically healthy male white rats weighing 150–200 g, housed under vivarium conditions in accordance with sanitary standards and good laboratory practice (GLP) principles. The experimental animals were randomly selected and assigned to four groups: Group I – intact animals (control, n = 10); Group II – animals with periodontitis on the 30th day of the experiment (n = 8); Group III – animals with periodontitis on the 30th day of the experiment, which were installed with acrylic bases (n = 8); Group IV – animals with periodontitis on the 30th day of the experiment, which were installed with nylon bases (n = 8).

Dentures were made using standard techniques: acrylic bases were produced through thermal polymerization using the polymethacrylate material 'Villacryl H Plus' (Zhermack, Italy) [12], and nylon

prostheses were created from the thermoplastic material 'Vertex ThermoSens' (Vertex, Netherlands) using compression molding [13]. The prosthetic structures were designed to avoid covering the occlusal surfaces of the teeth, while ensuring secure fixation on both central incisors of the lower jaw.

Experimental bacterial-immune periodontitis in animals was induced by injecting a mixture of microorganisms (*Staphylococcus aureus* and *Streptococcus hemolyticus*), suspended in egg white, directly into the periodontal tissues. Components of the cell wall of gram-positive bacteria, such as lipoteichoic acids, peptidoglycan, and lipoproteins, act as inflammatory triggers through toll-like receptors 2, facilitating pathogen recognition and activating innate immunity mechanisms. To enhance the immune response, the rats were simultaneously administered complete Freund's adjuvant. This procedure was repeated on the 14th day of the experiment to confirm the effectiveness of induction and chronicity of the bacterial-immune periodontitis [14]. On the 30th day, the experimental animals were euthanized by exsanguination under general anesthesia with sodium thiopental, and blood serum was collected for analysis of oxidative processes and peroxidation products.

The method for determining the concentration of TBA-active products (thiobarbituric acid-active products) was to use malonic dialdehyde, which forms a colored complex when reacted with thiobarbituric acid in an acidic medium. The study of the indicators of oxidative modification of proteins (OMP) in blood plasma was based on the reaction of oxidized amino acid residues with 2,4-dinitrophenylhydrazine (2,4-DNFH), which led to the formation of 2,4-dinitrophenylhydrazones. Aldehyde and ketone derivatives of a neutral characte were recorded at 370 nm (OMP_{370}), and the main one – at 430 nm (OMP_{430}). The optical density of the test sample was measured at 370 nm and 430 nm relative to the control sample on a SF-46 spectrophotometer. The levels of diene (DC) and triene conjugates (TC) were determined using a method based on the fact that hydroperoxides extracted with a heptane-isopropyl mixture exhibit a corresponding absorption maximum: DC at 232 nm and TC at 275 nm. The total concentration of nitric oxide metabolites in blood serum, including nitrite anion (NO_2^-), was determined by photometry on a photoelectrocolorimeter at a wavelength of 546 nm [15].

All experimental procedures were conducted in compliance with the guidelines of the 'European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes' (Strasbourg, 1986) and the 'General Ethical Principles for Experiments on Animals' (Kyiv, 2001) [16]. The study received approval from the Bioethics Commission of I. Horbachevsky Ternopil National Medical University of the Ministry of Health of Ukraine (protocol No. 78, dated August 18, 2024).

Data analysis was performed using nonparametric statistical methods in STATISTICA 10.0 software (StatSoft, USA). To analyze the obtained results, a variation series analysis was conducted, which involved calculating the arithmetic mean and its standard error (M and m). To evaluate the significance of differences between independent quantitative variables with a normal distribution, the Mann-Whitney U-test, based on nonparametric characteristics, was applied. All analyses were performed with a critical level of statistical significance (p) of less than 5% ($p<0.05$) [17].

RESULTS AND DISCUSSION

By the 30th day of the experiment, an active inflammatory process in the periodontal complex led to a marked elevation of lipoperoxidation products in the blood serum. This was confirmed by a rise in the concentration of diene conjugates (DC) (by 4.22 times; $p<0.001$) and triene conjugates (TC) (by 3.94 times; $p<0.001$), compared to the intact group of animals (Table 1, Fig. 1). In the group where acrylic bases were used on the 30th day of the pathological process, a gradual decrease in the concentration of diene conjugates (by 1.81 times; $p<0.001$) and triene conjugates (by 1.84 times; $p<0.001$) in the blood serum was observed compared to the group with periodontitis without prosthetics. However, these indicators remained elevated relative to the control group (by 2.34 times; $p<0.001$ and 2.14 times; $p<0.001$, respectively).

In the next observation group, on the 30th day of the pathological process with fixed nylon bases, the content of DC in the blood serum showed the same trend – it decreased in comparison with the indicators on the 30th day without prostheses by 1.51 times ($p<0.001$), but in relation to the results obtained when using acrylic structures, this indicator turned out to be higher by 1.20 times ($p<0.001$). The level of this metabolite in the blood serum significantly exceeded the indicators of the control group, increasing by 2.80 times ($p<0.001$).

The content of triene conjugates in animals with nylon structures changed in the same direction, but the decrease in their concentration in the blood serum was more pronounced – by 1.53 times ($p<0.001$) compared to the indicators on the 30th day of periodontitis development without bases. However, in this group, the level of TC was higher than the control values (by 3.94 times; $p<0.001$). When compared to the indicators in the group of animals with acrylic prostheses and experimental periodontitis, it is important to note that the concentration of this metabolite in the blood serum was significantly higher (by 1.21 times; $p<0.001$).

Table 1 – Activity indicators of free radical processes in the blood serum of experimental animals with induced bacterial-immune periodontitis and under prosthetic base fixation conditions (M±m)

Study conditions and metrics	Control (intact) group	Experimental periodontitis		
		No prosthetics	Acrylic base	Nylon base
Duration of the study (days)	-	30	30	30
Number of rats	10	8	8	8
DC (m. units/ml)	1.40 ± 0.06	5.91 ± 0.13 $p_1<0.001$	3.27 ± 0.09 $p_1<0.001$; $p_2<0.001$	3.92 ± 0.04 $p_1<0.001$; $p_2<0.001$; $p_3<0.001$
TC (m. units/ml)	1.60 ± 0.06	6.30 ± 0.12 $p_1<0.001$	3.42 ± 0.06 $p_1<0.001$; $p_2<0.001$	4.13 ± 0.06 $p_1<0.001$; $p_2<0.001$; $p_3<0.001$
DC / TC	0.89 ± 0.06	0.96 ± 0.02 $p_1>0.05$	0.95 ± 0.02 $p_1>0.05$; $p_2>0.05$	0.95 ± 0.02 $p_1>0.05$; $p_2>0.05$; $p_3>0.05$
TBA-active products (μmol/l)	0.59 ± 0.04	2.83 ± 0.12 $p_1<0.001$	2.50 ± 0.03 $p_1<0.001$; $p_2<0.05$	1.60 ± 0.06 $p_1<0.001$; $p_2<0.001$; $p_3<0.001$
$NO_2^-+NO_3^-$ (μmol/l)	0.542 ± 0.007	0.779 ± 0.006 $p_1<0.001$	0.746 ± 0.013 $p_1<0.001$; $p_2>0.05$	0.681 ± 0.007 $p_1<0.001$; $p_2<0.001$; $p_3<0.001$
OMP_{370} (mmol/ml)	0.239 ± 0.005	0.468 ± 0.003 $p_1<0.001$	0.421 ± 0.008 $p_1<0.001$; $p_2<0.001$	0.389 ± 0.004 $p_1<0.001$; $p_2<0.001$; $p_3<0.001$
OMP_{430} (mmol/ml)	0.275 ± 0.005	0.459 ± 0.005 $p_1<0.001$	0.396 ± 0.005 $p_1<0.001$; $p_2<0.001$	0.345 ± 0.008 $p_1<0.001$; $p_2<0.001$; $p_3<0.001$
OMP_{370} / OMP_{370}	0.87 ± 0.02	1.02 ± 0.02 $p_1<0.001$	1.07 ± 0.01 $p_1<0.001$; $p_2>0.05$	1.13 ± 0.03 $p_1<0.001$; $p_2<0.05$; $p_3>0.05$

Note: p_1 – significance of differences compared to the control group of animals; p_2 – significance of differences compared to the group of animals with bacterial-immune periodontitis on day 30 without prosthetic treatment; p_3 – significance of differences compared to the group of animals with bacterial-immune periodontitis on day 30 with the application of acrylic bases

When assessing the ratio of DC / TC content in blood serum (Table 1), it turned out that this indicator increased on the 30th day of the study during experimental bacterial-immune inflammation in the periodontium and under the conditions of using different types of prosthetic structures, compared with the indicators of the control group, however, the data were statistically insignificant ($p>0.05$).

When comparing the same ratio in rats of the studied groups, the differences were also statistically insignificant ($p<0.05$).

In pathological conditions, such as periodontitis or other inflammatory diseases, the concentration of TBA-active products increases as one of the markers of lipid peroxidation, which is a sign of tissue damage [18].

During the analysis of the indicator that determines the level of lipid peroxidation, in particular TBA-active products, significant changes were detected (Table 1). Specifically, on the 30th day of experimental periodontitis modeling in rats, the level of this indicator in blood serum was found to be 4.80 times higher ($p<0.001$) compared to the control group data.

On the 30th day of experimental periodontitis development with the use of acrylic bases, a decrease in the level of TBA-active products (by 1.13 times; $p<0.05$) was observed in the blood serum compared to the group of animals with the inflammatory process in the periodontal tissues without prosthetics. However, these levels remained significantly elevated compared to the control group of animals (by 4.24 times; $p<0.001$).

Research on the impact of thermoplastic nylon bases on the 30th day of the experiment revealed that the level of TBA-active products in the blood serum decreased (by 1.13 times; $p<0.05$ and by 1.56 times; $p<0.001$) when compared to the group of animals with experimental periodontitis without prosthetics and the group using polymethylacrylate structures. However, the concentration of TBA-active products in this group of rats was by 2.71 times higher ($p<0.001$) than in the intact group of rats (Fig. 1).

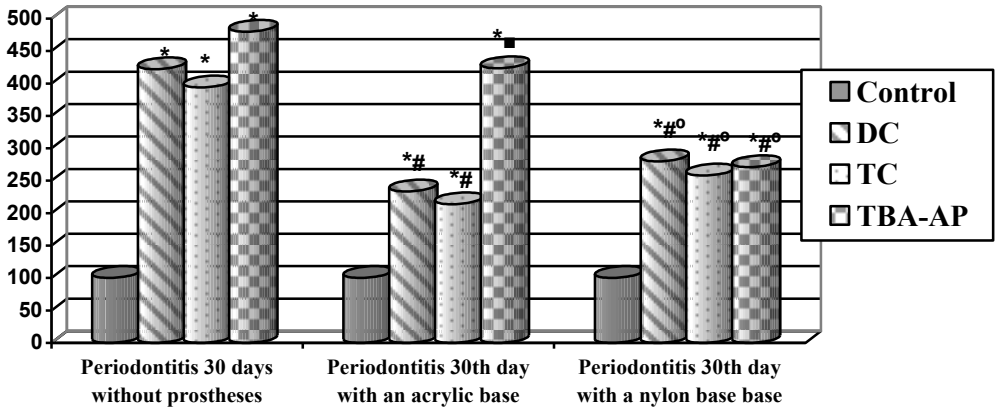

Figure 1 – Changes in lipid peroxidation indices during the progression of bacterial-immune periodontitis and the application of prosthetic bases (in % of control)

Note. * – indicates statistical significance of differences compared to the intact group of animals (p<0.001); # – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day without prosthetics (p<0.001); ■ – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day without prosthetics (p<0.05); º – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day with acrylic bases (p<0.001)

At the studied stage of the development of experimental periodontitis, namely on the 30th day, a significant increase in the concentration of nitrogen (II) oxide metabolites (NO_2^-+NO_3^-) in the blood serum was detected, which indicates the activation of free radical processes (by 1.44 times increase; p<0.001), relative to the control group. Such changes may be due to compensatory mechanisms that try to limit oxidative stress, but at the same time maintain an increased level of inflammation (Fig. 2) [19].

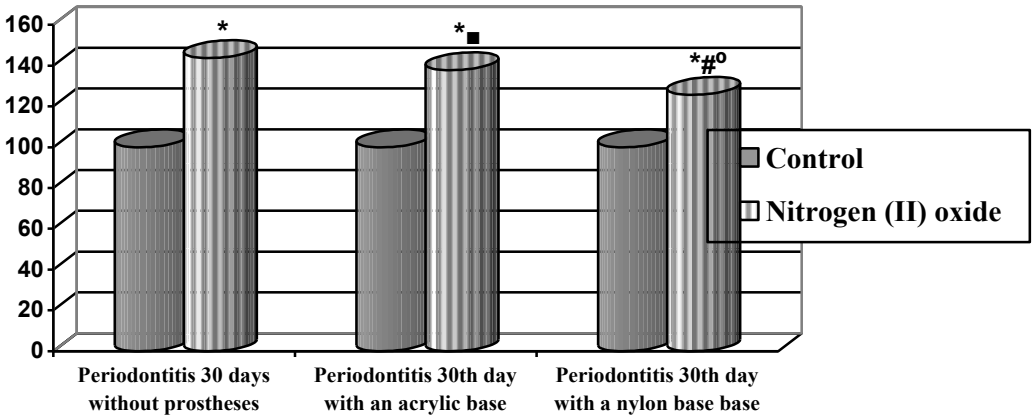

Figure 2 – Changes in nitrogen (II) oxide content during the progression of bacterial-immune periodontitis and the application of prosthetic bases (in % of control)

Note. * – indicates statistical significance of differences compared to the intact group of animals (p<0.001); # – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day without prosthetics (p<0.001); ■ – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day without prosthetics (p<0.05); º – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day with acrylic bases (p<0.001)

Analysis of changes in nitrogen (II) oxide metabolism in the blood serum of experimental animals with inflammation and acrylic prostheses indicates that the concentration of this reactive oxygen species also increased significantly (by 1.38 times; p<0.01) compared to the control group. However, this indicator was slightly lower than in animals without the use of bases, although this difference was not statistically significant, which indicates the preservation of free radical processes and disruption of the dynamic balance between oxidative stress and antioxidant protection.

The application of prostheses with nylon bases resulted in significant changes in the levels of nitrogen (II) oxide metabolism products in the blood serum of experimental animals with periodontitis (see Table 1, Fig. 2). When fixing this type of removable prosthetic structures, the level of NO in the blood serum decreased (by 1.14 times; $p<0.01$), relative to animals with experimental periodontitis on the 30th day without prosthetics, which indicates a decrease in the dynamic balance between the antioxidant defense system and free radical processes in the body. At the same time, this indicator was by 1.26 times higher ($p<0.001$) than the values of the control group of animals. If we compare this indicator with the indicators of the group with acrylic prostheses, its concentration in the blood serum, nevertheless, decreased, that is, was lower (by 1.10 times; $p<0.001$).

As the data in the table show, on the 30th day of the experiment in animals with periodontitis, the level of products of oxidative modification of neutral proteins (OMP_{370}) increased by 1.96 times ($p<0.001$) compared to the intact group. On the 30th day with prosthetics with acrylic bases, their content was lower, decreasing by 1.11 times ($p<0.001$) compared to the indicators of the same day, but without prosthetics, but remained significantly increased – by 1.76 times ($p<0.001$) compared to the intact group (Fig. 3).

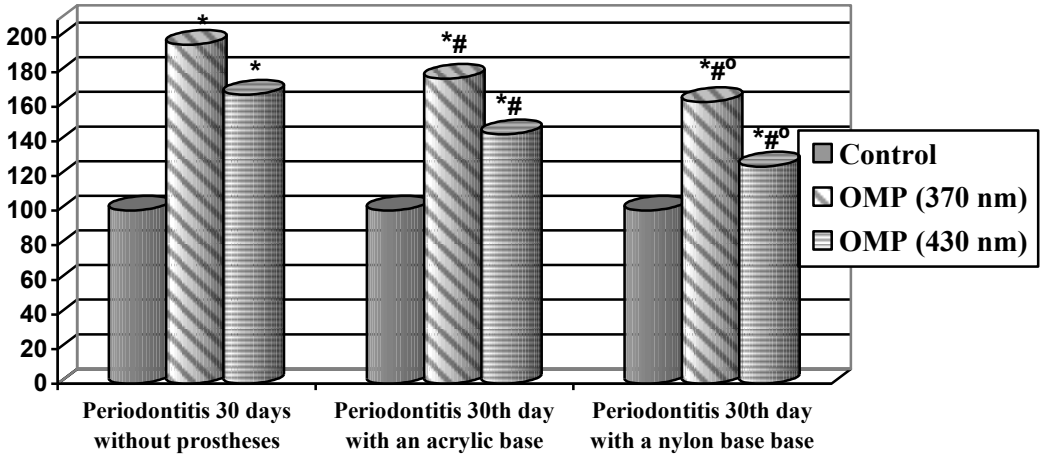

Figure 3 – Changes in the content of OMP during the progression of bacterial-immune periodontitis and the application of prosthetic bases (in % of control)

Note: * – indicates statistical significance of differences compared to the intact group of animals ($p<0.001$); # – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day without prosthetics ($p<0.001$); ° – indicates statistical significance of differences compared to the group of animals with bacterial-immune periodontitis on the 30th day with acrylic bases ($p<0.001$)

On the 30th day of experimental periodontitis, when using thermoplastic nylon plastic, the level of the aldehyde and ketone derivatives decreased by 1.20 times ($p<0.001$) compared to the group without prosthetic bases. However, the values were still slightly lower compared to the group with polymethacrylate bases (by 1.08 times; $p<0.001$). Despite this, the indicator remained significantly higher compared to the intact group – by 1.96 times ($p<0.001$).

On the 30th day of experimental periodontitis development, there was a 1.67-fold increase ($p<0.001$) in the levels of oxidative modification products of basic proteins (OMP_{430}) in the blood serum compared to the control group. However, with acrylic prosthetics, this indicator decreased by 1.16 times ($p<0.001$) relative to rats without prosthetics, although it remained elevated compared to the intact group of animals – by 1.44 times ($p<0.001$) (Fig. 3).

In experimental animals with bacterial-induced immune periodontitis and the use of nylon prosthetic structures, the concentration of aldehyde and ketone derivatives of the primary nature showed a slight decrease compared to the groups with inflammation in the periodontium without prosthetics and with acrylic prosthetics – by 1.16 times ($p<0.001$) and by 1.15 times ($p<0.001$), respectively. However, the level of aldehyde and ketone derivatives remained significantly higher compared to the control group – by 1.67 times ($p<0.001$).

The analysis of the ratio of aldehyde and ketone derivatives of neutral and basic nature in the blood plasma of rats with periodontitis, under different prosthetic conditions, revealed the following changes: On the 30th day of the inflammatory reaction, both with and without prosthetics, there was an increase in the ratio by 1.17 times ($p<0.001$) without prosthetics, by

1.23 times ($p<0.001$) with acrylic bases, and by 1.30 times ($p<0.001$) with nylon bases, compared to the control group. The use of polymethacrylate plastic prosthetics led to a decrease in this ratio compared to the group without prosthetics; however, these changes were not statistically significant ($p>0.05$).

By the 30th day, in rats with periodontitis using thermoplastic nylon bases, the OMP_{370}/OMP_{430} ratio showed a slight increase compared to the group without prosthetic structures (by 1.11 times; $p<0.05$). This may indicate the reactivation of free radical processes, heightened oxidative activity during this period, or a delay in the recovery of antioxidant defense mechanisms.

A comparison of the OMP_{370}/OMP_{430} ratio in rats from the third and fourth experimental groups revealed no significant differences between the groups ($p>0.05$). This suggests that the oxidative modification of proteins in blood serum in these groups is driven by similar mechanisms, resulting in no substantial variation in these indicators.

Alterations in the activity of lipid peroxidation (LPO) processes in blood serum serve as a crucial indicator of tissue dysfunction within the body. LPO is a key contributor to the progression of various pathological conditions, including inflammatory and degenerative processes [20]. The increased activity of LPO is driven by elevated levels of free radicals, which interact with unsaturated fatty acids in cell membranes. This interaction results in the formation of both primary (diene and triene conjugates) and secondary (TBA-active products) oxidation products [21].

The findings from the study demonstrate a high level of reactive oxygen species generation and the activation of free radical lipid oxidation during the observed period of inflammatory reaction development, regardless of whether prosthetic structures were used or not.

The observed increase in TBA-active product levels during the experiment reflects the intense activation of free radical lipid oxidation processes that persisted throughout the formation of the inflammatory response. This increase signifies substantial disruptions in the structure and function of cell membranes, driven by oxidative stress, which is a key factor accompanying the progression of inflammation [22].

It is crucial to note that during the progression of bacterial-immune experimental periodontitis, there was active generation and accumulation of intermediate toxic products of lipid peroxidation in the blood serum. These products, formed at various stages of the lipid peroxidation chain reaction, indicate a disruption of homeostasis and the activation of oxidative stress, which are hallmark features of inflammatory processes [23].

Nitric oxide (NO) is among the most reactive and unstable products of free radical oxidation, as it quickly interacts with other molecules to generate metabolites such as nitrite ((NO_2^-)) and nitrate (NO_3^-). These metabolites are considered unstable due to their ability to further react within the body, thereby contributing to oxidative stress and tissue damage. Moreover, they can take part in forming complex, potentially toxic compounds that disrupt normal cellular and biochemical processes. Such oxidative damage plays a significant role in inflammatory conditions, particularly in diseases like periodontitis [24, 25].

The analysis of the experimental findings highlights the continuous production of NO, which plays a key role in the broader inflammatory mechanisms driving the progression of periodontitis, irrespective of the type of removable prosthetic structure used. This ongoing process underscores the involvement of oxidative pathways and the interplay between molecular systems, such as NO and antioxidants, which can either amplify or modulate the inflammatory response in periodontal tissues [26].

Protein oxidative modification serves as a critical marker of free radical processes during inflammation, contributing to the activation of proteolysis in proteasomes and amplifying tissue damage at inflammatory sites [27]. OMP alters protein structure, leading to aggregation, fragmentation, and increased vulnerability to proteolytic degradation. These modified proteins become primary targets for antioxidants and enzymes that mitigate their harmful effects on cells [28]. Unlike lipid peroxides, OMP products demonstrate greater stability and are efficiently metabolized by low-molecular-weight antioxidants, such as glutathione, and peroxidase system enzymes, making them reliable indicators of oxidative stress [29]. The experimental data on aldehyde and ketone derivatives of neutral and basic character in blood plasma highlight the dynamic nature of protein oxidative modification processes. These dynamics may correlate with shifts in inflammation intensity and the activation of antioxidant defense mechanisms when using removable prosthetic devices.

CONCLUSIONS

The inflammatory process in the periodontal complex with a bacterial-immune component is characterized by heightened oxidative stress, homeostasis disruption, and the increased production of lipoperoxidation products, OMP, and NO metabolites. Elevated levels of diene and triene conjugates reflect the activation of free radical processes triggered by inflammation, while an increase in TBA-active products signifies oxidative stress-induced damage to cell membranes. Additionally, the substantial rise in OMP

levels further confirms the intense activation of free radical mechanisms. The application of acrylic and nylon bases reduces the concentration of peroxidation products, suggesting that prosthetic structures have a partial impact on mitigating oxidative stress; however, inflammatory activity persists. Prosthetics, particularly those with nylon bases, led to a slight reduction in NO levels, indicating a potential weakening of oxidative processes and some alleviation of oxidative stress. Nonetheless, the findings highlight the need for additional intervention with antioxidant therapies to achieve more effective correction.

PROSPECTS FOR FUTURE RESEARCH

Future studies should be aimed at clarifying the impact of different types of bases of removable prosthetic structures on the body's antioxidant defense system, cytokine status, and the innate and acquired immune system.

AUTHOR CONTRIBUTIONS

All authors substantively contributed to the drafting of the initial and revised versions of this paper. They take full responsibility for the integrity of all aspects of the work.

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A – Work concept and design,
B – Data collection and analysis,
C – Responsibility for statistical analysis,
D – Writing the article,
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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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