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Clinical and Biochemical Characteristics of Adaptation in Patients with Complete Edentulism to Removable Plate Dentures

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Annotation: Complete edentulism is still considered one of the key problems in orthopedic dentistry, as it leads to impaired chewing efficiency, deterioration of aesthetics, and reduced overall quality of life in patients, especially elderly ones. Prosthetic treatment in the absence of teeth is accompanied by additional load on prosthetic bed tissues, which manifests as activation of lipid peroxidation (LPO) processes and changes in the functioning of the antioxidant system (AOS).

Thus, biochemical analysis of oral fluid can serve as an objective criterion for evaluating patient adaptation to removable prostheses and be used to optimize orthopedic treatment and prevent possible complications.

Keywords: complete edentulism, removable prostheses, adaptation, lipid peroxidation, antioxidant system.

Introduction. Complete tooth loss remains one of the most significant medical and social problems of modern orthopedic dentistry. Edentulism causes pronounced dysfunction of the dentoalveolar system: reduced chewing efficiency, difficulties in articulation, deterioration of facial aesthetics, and consequently, development of psychological discomfort, which collectively significantly reduces patients' quality of life. This problem is most pronounced in elderly individuals, as their compensatory and adaptive resources are limited [2,5,9].

The use of removable prostheses remains the most common and accessible method of restoring lost functions. However, the process of adapting to complete removable constructions is accompanied by a number of difficulties caused by both local anatomical-functional changes in the oral cavity and systemic body reactions. In recent years, researchers have shown particular interest in analyzing biochemical processes in oral fluid, which reflects the response of prosthetic bed tissues to the impact of orthopedic constructions [1,4,12].

An important element of adaptation mechanisms is the relationship between lipid peroxidation (LPO) and antioxidant system (AOS) activity. Excessive activation of free radical processes and accumulation of LPO products leads to damage to cell membranes and connective tissue components, which can provoke inflammatory changes and complicate adaptation processes. At the same time, the antioxidant system plays a key role in neutralizing reactive oxygen species and provides protection of prosthetic bed tissues from oxidative damage [3,6,8].

Thus, prosthetic treatment with removable constructions can be considered as a stress factor that triggers a cascade of free radical reactions. In this regard, studying the dynamics of LPO indicators and AOS activity appears relevant for evaluating the effectiveness of orthopedic treatment and understanding adaptation mechanisms in patients with complete edentulism [7,10].

Study objective – to study changes in the lipid peroxidation system and antioxidant protection of oral fluid in patients with complete edentulism at various times after prosthetic treatment with complete removable constructions.

Materials and Methods. The study included 40 patients aged 50 to 79 years, including 18 women and 22 men, who underwent prosthetic treatment with complete removable plate dentures. To evaluate the effectiveness of orthopedic treatment and features of adaptation processes, dynamic observation of changes in lipid peroxidation (LPO) indicators and antioxidant system (AOS) activity was conducted at various times. Examination was performed before the start of prosthetic treatment, as well as 7, 30, 180, and 360 days after prosthesis placement, which allowed tracking both early and long-term changes in biochemical characteristics of oral fluid.

For biochemical analysis, unstimulated oral fluid was collected from patients according to generally accepted methods [8, 9]. The obtained material was centrifuged at 3000 rpm for 15 minutes, after which both supernatant and sediment were used for research, ensuring comprehensive evaluation of soluble and cellular components.

The intensity of lipoperoxidation processes was determined by the content of secondary products of lipid peroxidation using the reaction with 2-thiobarbituric acid. The method is based on the interaction of malondialdehyde — the main marker of lipoperoxidation — with thiobarbituric acid to form a colored complex, whose optical density was registered spectrophotometrically at a wavelength of 540 nm. Product concentration was expressed in μmol of malondialdehyde per liter of oral fluid [4, 11], which allowed objective assessment of oxidative stress levels.

The enzymatic component of AOS was studied by the activity of superoxide dismutase (SOD) and catalase. Catalase activity was determined by the colorimetric method [8, 10], based on the ability of hydrogen peroxide to form a colored complex with molybdenum salts. The amount of undecomposed substrate reflected the level of enzyme activity; results were expressed in μmol/min per gram of protein. SOD activity determination was performed according to the method of V.A. Kostyuk et al. (1990) [4, 8], according to which the enzyme, by dismutating superoxide anion radical, inhibited quercetin autooxidation. Indicators were expressed in conventional units per gram of oral fluid protein.

The state of the non-enzymatic component of AOS was evaluated by the content of non-protein thiol groups. The method is based on their interaction with 5,5'-dithio-bis-(2-nitrobenzoic) acid to form a colored compound, whose optical density was registered at 412 nm. Concentration was determined in mmol/L of oral fluid [6, 11], which made it possible to assess antioxidant protection at the level of low-molecular-weight compounds.

All obtained data underwent statistical processing using methods of variation analysis and the STATISTICA 6.0 software package, which ensured high reliability of results and allowed identification of patterns in the dynamics of adaptation processes.

Results. Enhancing the functional value of removable prostheses remains one of the current tasks of orthopedic dentistry. Tooth loss is accompanied by impaired chewing function, which affects the condition of the gastrointestinal tract and metabolic processes in the body. The largest proportion of patients requiring prosthetic treatment for dental defects with removable constructions falls on individuals over 50 years of age with secondary edentulism — 40.2%. However, removable prostheses are also used quite frequently in younger people — from 15 to 20%.

Metal alloys and plastics are traditionally used for manufacturing bases of partial removable prostheses. For decades, the main material has been polymers based on methyl methacrylate, which have a number of known disadvantages. In recent years, thermoplastic plastics (thermoplasts) have become an alternative, distinguished by the absence of residual monomer, high plasticity, precision in manufacturing, and variety of color shades.

Enhancement of lipid peroxidation (LPO) processes and weakening of antioxidant protection is a universal pathogenetic mechanism observed in stress damage, inflammation, intoxication, burns,

diabetes mellitus, and other conditions. Prosthetic treatment can be considered as a stress factor that has a damaging effect on prosthetic bed tissues, so monitoring LPO levels represents an objective indicator of dental apparatus tissue adaptation to various orthopedic constructions.

According to our data, patients with partial and complete edentulism showed activation of LPO processes in oral fluid (Table 4). Thus, the content of TBA-reactive products increased by 279.7% ($p<0.001$) in the control group and by 266.4% ($p<0.001$) in the main group.

Activation of free radical oxidation and accumulation of LPO products can damage key components of connective tissue, particularly collagen. Under the influence of free radicals, the elasticity of collagen fibers decreases, their renewal is impaired, and amino acid residue hydroxylation processes intensify, leading to increased content of hydroxyproline and hydroxylysine. This has an adverse effect on periodontal tissues and may accelerate further tooth loss.

The reasons for sharp shift of the pro-/antioxidant balance toward prooxidants cannot be explained solely by spontaneous oxidation. According to literature data, an important factor may be increased concentration of metal ions with variable valence in oral fluid. As a result, LPO disturbances are exacerbated by functional insufficiency of enzymatic and non-enzymatic components of the antioxidant system (AOS).

To evaluate adaptation processes, the dynamics of LPO indicators and antioxidant protection were analyzed before treatment, as well as on days 7, 30, 180, and 360 after prosthetic treatment.

The activity of the first-line antiradical protection enzyme — superoxide dismutase (SOD) — in patients with complete edentulism (groups I and II) was significantly lower than in controls: the decrease was 20.9% ($p<0.001$) and 25.3% ($p<0.001$), respectively. The most pronounced decrease was recorded in the clinical control group — by 34% ($p<0.001$). Opposite dynamics were noted for the second-line antiradical protection enzyme — catalase: its activity was higher by 12.8% ($p<0.001$) in the clinical control group, by 20.7% ($p<0.001$) in group I, and by 22.4% ($p<0.001$) in group II compared to the main group.

Multidirectional changes in SOD and catalase activity indicate imbalance in the enzymatic component of AOS. SOD inhibition promotes accumulation of reactive oxygen species (ROS) in the oral cavity, which, in turn, can suppress its activity through irreversible changes in the enzyme's active center (for example, copper reduction or thiol group oxidation). Conformational rearrangements of the molecule lead to loss of functional activity by the enzyme. Increased catalase activity can be explained both by enhanced synthesis and secretion by salivary glands from systemic circulation.

Weakening of antioxidant protection and accumulation of LPO products may be due to insufficient intake of antioxidants with food, impaired chewing function, changes in digestion and nutrient absorption processes. An additional factor is deterioration of microcirculation in periodontal tissues, limiting the delivery of antioxidants to the oral cavity.

Thus, in patients with edentulism, the following were identified in oral fluid: activation of free radical oxidation of biomolecules, shift of prooxidant-antioxidant balance toward prooxidants, decreased activity of enzymatic (SOD) and non-enzymatic (thiols) components of the antioxidant system, as well as compensatory enhancement of catalase activity. Analysis of LPO and AOS indicator dynamics showed a tendency toward normalization as early as day 30 after prosthetic treatment, more pronounced in patients of the main group.

Conclusion. The conducted study showed that prosthetic treatment in complete and partial edentulism is accompanied by significant changes in the lipid peroxidation system and antioxidant protection of oral fluid. In early periods, activation of free radical processes is noted, manifested by accumulation of LPO products, decreased superoxide dismutase activity, and compensatory increase in catalase activity. These changes reflect imbalance in the enzymatic component of the antioxidant system and can be considered as a universal pathogenetic mechanism of prosthetic bed tissue adaptation to the stress impact of prosthetic treatment.

Depletion of non-enzymatic antioxidants and reduction of overall antioxidant protection in patients with edentulism are caused not only by impaired chewing function and reduced nutrient absorption, but also by deterioration of periodontal tissue microcirculation. The combined effect of these factors enhances the shift of prooxidant-antioxidant balance toward the prooxidant direction, which increases the risk of progression of destructive changes in oral cavity tissues.

At the same time, dynamic analysis of biochemical indicators showed a tendency toward their normalization by day 30 after prosthetic treatment, which indicates the body's ability to restore functional balance with adequate orthopedic rehabilitation. The most pronounced positive changes were recorded in patients of the main group, which emphasizes the importance of rational choice of prosthetic constructions and quality of clinical-laboratory support.

Thus, comprehensive evaluation of lipid peroxidation processes and antioxidant system state in oral fluid can serve as an objective criterion for patient adaptation to removable prostheses. Including biochemical monitoring methods in orthopedic dentistry practice allows not only to increase the effectiveness of orthopedic treatment but also to prevent the development of possible complications associated with impairment of local and systemic antioxidant protection mechanisms.

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