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METHODS FOR DETERMINING BIOSOCOMPATIBLE METAL ALLOYS FOR THE PREVENTION OF ELVANOSSES IN PERSONS RESIDING IN ECOLOGICALLY UNFAVORABLE CONDITIONS

Abstract: The article is about improving methods for determining the biocompatibility of metal alloys obtained by optimal technological procurement using the portable expert diagnostic system "Lira-100"; and to prevent the phenomena of galvanic oral cavity, as well as to study the compensatory-adaptive changes in the oral cavity. For this, a total of 103 patients (53 women and 50 men from 39 to 63 years old) wearing metal prostheses of various designs were examined; 59 patients wearing metal prostheses cast from granules and 44 wearing metal prostheses made from a rod, who were previously diagnosed with oral plating living in adverse environmental zones.

Key words: biocompatibility, metal alloys, diagnostic system "Lira-100", electroplating, oral cavity, metal prostheses, adverse environmental zones.

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Introduction

We know that at the orthopedic dental appointment in persons using metal dentures, there are phenomena of intolerance to structural materials, galvanosis, toxic stomatitis and delayed contact allergic reactions in the form of inflammation in the places where the metal parts of the prostheses adhere to the oral cavity (OC). At the same time, patients complain of a metallic taste, a burning sensation and tingling of the tongue, a distortion of taste sensitivity, a feeling of various tastes. Headaches, dizziness,

weakness, fatigue, nausea, vomiting, indigestion, sleep disturbances, heart pains are often noted [3, 4, 6, 7, 8, 9, 10, 12].

As far as we know today, despite the development of new technologies, the number of people with symptoms of intolerance to certain metals or alloys, such as nickel-chromium alloys, especially stainless steel, continues to increase, the corrosion products of which enter the OC, accumulate in saliva, biological fluids and body tissues. [1, 2, 3, 5, 7, 13, 14].

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Purpose of the work: To determine the biocompatibility of metal alloys obtained by means of optimal technological workpieces; cast bar billets Ø12mm or granules Ø2-6mm, alloy on a cobalt-chromium base, type KHS, using a portable expert diagnostic system "Lira-100", which allows to improve the methodology for determining and prevent the phenomena of galvanosis OC, as well as to study compensatory and adaptive changes in OC.

II. Literature review

When receiving traditional billets for casting alloys of the KHS type in the form of rods, the main technological stages consisted of such main stages as melting, sandblasting, tumbling and cutting of rods into measured parts.

In this case, there is a mechanical effect on structural alloys. To obtain the pellets, a vacuum unit for melting pellets Indutherm (Germany) was used and the entire technological process, in addition to melting, consisted only of pellet tumbling. To study the structure of cast semifinished products, metallographic studies were used: macro and microscopic methods of analysis in accordance with accepted standards. The composition of the alloys under study was determined by X-ray microanalysis.

The response of the patient's OC tissues to the sample material was assessed using the Lira-100bt expert diagnostic complex, developed and manufactured in Russia, which meets the requirements of GOST 19687-89, GOST R 50444-92, technical specifications TU 9442-001-41971715-2007, series 66, OGRNIP 305667405300010.

III. Analysis

A total of 103 patients (53 women and 50 men from 39 to 63 years old), wearing metal prostheses of various designs, 59 patients wearing metal prostheses cast from granules, and 44 patients wearing metal prostheses made from a rod, who were previously diagnosed with OC galvanosis, were examined.

The study was carried out by comparing the values of the coefficient of functional asymmetry of the initial measurement and the coefficient of functional asymmetry obtained when measuring with the test sample. The coefficients are calculated using the software of the expert diagnostic complex "Lira-100", which is based on the analysis of changes in the parameters of bioelectric reactivity (BEMR) of living tissues of the organ - the response electromagnetic signal, due to which the presence of pathological processes in the tissues under study is determined with high accuracy [1, 2, 9].

In order to study the content, reduced glutathione and the activity of glutathione-dependent pancreatic enzymes at different degrees of secondary adentia in patients, we divided as a comparison group in the case of replacement of the defect with one-piece bridges (group IV), we used clinical group I (absence of 1-3

teeth). The comparison groups for the V (clasp) and VI (lamellar prostheses) groups were respectively II (absence of 4-10 teeth) and III (complete edentulous) clinical groups.

In order to study the effect of pH-saliva on dentures in patients, it was carried out using a pH-millivoltmeter "pH-410" during the initial examination on the day of fixation of the structures and after 6 months. Measurements of the electrochemical potentials of metal inclusions in the OC were carried out using the device "Universal Ionomer EV-74" [5,8, 9].

Observing the patients, a clinical assessment of the manufactured prostheses was carried out according to the modified basic criteria [7, 8]. The condition of dentures in the examined patients was assessed after the manufacture of new dentures and after 6 months.

To assess secretory immunity, oral fluid (OF) was obtained, which was a mixed saliva. The concentration of lactoferrin (Lf) and secretory immunoglobulin A (IG A) was determined in the pancreas by the method of heterogeneous enzyme-linked immunosorbent assay using the "Vector-Best" test systems.

In order to assess the nonspecific resistance of OOPR, the reaction of adsorption of microorganisms by the cells of the buccal epithelium was used [8,12].

Statistical processing of the results was carried out on the basis of the principles of variation statistics according to the Student's criteria using the computer statistical programs Statistica 8.0. To analyze the relationship between the signs, the Spearman correlation analysis was used. Differences were considered statistically significant at $p < 0.05$.

The amount of metal suitable for use with traditional technology is 45-50%, with metal losses up to 18-20%, the granulation technology allows to obtain up to 80-90% of usable metal, with losses = 1.5%. The study of the work of a dental technician - a foundry worker has shown that when using a granular form of workpieces it allows them to be quickly and evenly heated, because the weight of granules Ø2.0-6.0 mm is 0.1-0.6g, with the weight of bar blanks Ø12mm — 12.0-15.0g. The melting time of 50 grams of billets in the form of rods averages 190 ± 2 seconds, at 100 ± 2 seconds in a new shape of billets.

Comparative analysis of the structure and composition of metal alloys after casting, carried out by metallographic and chemical-spectral methods, showed that the average distance between the ages of the dendrites in the KHS alloy samples obtained from rods is 24 µm, while the average distance between the ages of the dendrites of the alloy samples cast from granules 13 microns. An indicator such as liquation in the first group is higher ($\Delta Mo = 6.5 \pm 5.2\%$; $\Delta Cr = 28.0 \pm 3.1\%$) than in the second ($\Delta Mo = 6.5 \pm 1.5\%$; $\Delta Cr = 28.0 \pm 0.9\%$). The number of non-metallic inclusions in products made from rods is also higher:

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it is 11 per unit area versus 5 per unit area in dentures cast from granules.

Another important indicator - the waste for the alloy in the rods is 0.24%, against the analogous indicators of the samples obtained from granules - 0.16%. The most suitable for patients was the KHS alloy, produced in the form of granules, in which the coefficient of functional asymmetry is close to the control line. The subsequent prosthetics performed using the KHS alloy, produced in the form of granules, showed the absence of complaints in all studied patients.

In order to detect galvanic phenomena in OC, leading to the appearance of galvanosis, a special sensor D2 with a metal tip was used with the help of the Lira-100 device.

As a result of the calculations, it was revealed that in all examined patients, whose dentures were made from KHS, produced in the form of granules, that $V1 > V2$ was less than 30%, which indicates the permissible values of electrical potentials [5, 7], and the data for presence of galvanose OC no.

Pathological changes in OC against the background of constant interaction with harmful physical and chemical products of metallurgical production, primarily with functional and organic

disorders in the salivary glands [9, 10, 11, 12, 13, 14], which is confirmed by our data.

Complaints of frequent thirst were presented by those wearing prostheses made from a rod - 19.23% of patients in the main group (MG) and 5.88% of patients wearing prostheses made of granules, in the control group (CG) there were no such complaints. The sensation of dryness in OC occurs in 34.62% of patients with MG, in 11.76% of patients in CG. The nature of changes in indicators of gastric secretory immunity depended on the type of material of the prosthesis made: there was a decrease in the level of lactoferrin by 23.2% ($p \leq 0.05$) and a tendency towards a decrease in the concentration of secretory IG A by 26.3% ($p > 0.05$), compared with the indications of the control group (table No. 1). An analysis of the results of the examined patients indicates that the average value of the PMA index in the main group was $47.4 \pm 1.36\%$, which corresponds to moderate severity, and in the CG group $14.9 \pm 1.62\%$. We did not reveal significant differences in the degree of inflammation of the gingival mucosa in persons with dentures, the frameworks of which were cast from both granules and rods, but pathology was often found in patients with CG.

Table №1. Indicators of lactoferrin, secretory IHA, adsorption of microorganisms

Patient group	Lactoferrin / ml	Secretory IHA mg / ml	Adsorption of microorganisms, SCC
Control group	6005,6± 328,0	165,0±12,4	2,0±0,3
Main group	3915±231,3	137±16,9	1,6±0,4

MMOC such as benign tumors - 8.2%; leukoplakia - 4.3%; cheilitis - 5.9%; swelling of the tongue and cheek - 44.9%; raids in the language - 68.2%; folded tongue - 12.7%; burning of the tongue - 9.4%; dry mouth -46.4%; bitterness in the mouth - 23.2%; inflammatory diseases of periodontal tissues 60.5%: in the CG 1.7%; 0%; 3.3%; 23.7%; 31.7%; 2.4%; 0%; 17.8 %%, 5.4%; 59.7% respectively.

Based on the obtained values of the electrochemical potentials, a galvanogram was made and the EMF was calculated. The results of the study of EMF in patients of different groups are presented in table №2.

The study of gastric acid pH indices showed that despite a slight shift in pH - to the acidic side in patients with all-metal prostheses from a rod and in patients with prostheses from a granule, comparable results were: 7.0 ± 0.2 and 5.8 ± 0.4 , respectively ($p < 0.05$). The pH of saliva has a significant shift towards the acidic side in patients with dental prostheses made from KCS in the form of rods. In our opinion, this is due not only to the presence of dentures made of KCS alloys in OC, but also to the effect of microbiological, immunological and biochemical factors that contribute to the progression of inflammatory diseases of OC.

Table №2. Indicators of potential difference in patients of different groups

Study groups	Types of dentures	Indicators of the difference of electrochemical potentials
Control group. n = 44; man = 16 women = 28	Sintered metal	40±10
	Metal acrylic	50±10
	All-metal	30±10

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Main group: n = 59; man = 22 women = 37	Sintered metal	30±10
	Metal acrylic	40±10
	All-metal	40±10

Appendix: Significance of differences P <0.05.

As a result, in a detailed analysis of the distribution of cells of different categories, it was found that when using blanks of the traditional type in the form of rods, the number of cells that adsorbed more than 50 microbial bodies is one and a half times reduced ($p = 0.04$). This indicates a partial inhibition of the mechanisms of immunoreactivity of the MMOC in the presence of a metal frame cast from billets in the form of rods, where the worse indicators of the dispersion of the dendritic structure, liquation heterogeneity ($\Delta Mo \pm 5.2\%$; $\Delta Cr \pm 3.1\%$) and a large number of nonmetallic inclusions [10, 11, 13, 14].

Corrosion products (iron, copper, manganese, chromium, etc.) enter the OC, accumulate in saliva, biological fluids and body tissues.

As studies have shown, in OC patients with partial edentulousness before prosthetics in the absence of 1-3 teeth, the GSH content decreased by 21% ($p < 0.02$) compared with the data obtained in healthy people. In the absence of 4-10 teeth in the gastric cancer, the GSH level decreased by 37.0% ($p < 0.001$), and in patients with complete adentia - by 54.0% ($p < 0.001$), compared with the values in the control group.

IV. Discussion

The activity of glutathione-dependent enzymes in the gastric cancer of edentulous patients before prosthetics also decreased (table 3).

Thus, the activity of GPO decreased by 22.7% ($p < 0.001$), and GR by 30.2% ($p < 0.001$) in the absence of 1-3 teeth in patients; by 48.3% ($p < 0.001$) and

32.7% ($p < 0.001$) in the absence of 4-10 teeth compared to the enzyme activity in the group of people with intact dentition. In the group of patients with complete adentia, the most pronounced decrease in the activity of oxidase and reductase enzymes involved in the metabolism of glutathione was observed. The GP activity in the III clinical group decreased by 58.3% ($p < 0.001$), and GR - by 38.8% ($p < 0.001$) compared with the data in the control group. The content of reduced glutathione and the activity of glutathione-dependent pancreatic enzymes at various degrees of secondary adentia in patients not subjected to dental prosthetics ($M \pm m$).

According to the data obtained, the GSH level in the gastric cancer of patients of the IV clinical group was 35.2% ($p < 0.001$) lower than the data obtained in the I - group. The content of reduced glutathione in group V was lower by 65.3% ($p < 0.001$) compared with the data in group II. The maximum decrease in GSH concentration was found during the replacement of dentition defects with removable lamellar prostheses.

The content of reduced glutathione in the VI - clinical group was $12.35 \pm 2.42 \mu\text{mol} / \text{g}$, which was 56.0% less ($p < 0.001$) compared with the data obtained in the III group.

In the course of the studies, it was found that at the time of examination in patients of IV, V and VI clinical groups, there was a significant imbalance in the work of glutathione-dependent pancreatic enzymes.

Table №3. The activity of glutathione-dependent enzymes in the stomach of edentulous patients before prosthetics also decreased

Groups of examined		GSH, $\mu\text{mol} / \text{l}$	GPO, $\mu\text{mol} / (\text{min} \cdot \text{g protein})$	GR, $\mu\text{mol} / (\text{min} \cdot \text{g protein})$
I (patients with missing 1-3 teeth)	21	48,13±3,22 $p_{1-7} < 0,02$	38,69±2,39 $p_{1-7} < 0,001$	21,45±1,60 $p_{1-7} < 0,001$
II (patients with frequent adentia, who lacked 4-10 teeth)	10	38,36±2,04 $p_{2-7} < 0,001$ $p_{1-2} < 0,02$	25,86±1,51 $p_{2-7} < 0,001$ $p_{1-2} < 0,001$	20,68±1,24 $p_{2-7} < 0,001$ $p_{1-2} > 0,5$
III (patients with complete absence of teeth in the upper and lower jaws)	10	28,05±1,10 $p_{3-7} < 0,001$ $p_{1-3} < 0,001$ $p_{2-3} < 0,001$	20,88±1,65 $p_{3-7} < 0,001$ $p_{1-3} < 0,001$ $p_{2-3} < 0,05$	18,81±1,17 $p_{3-7} < 0,001$ $p_{1-3} < 0,5$ $p_{2-3} < 0,5$

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IV (patients with one-piece fixed bridges made of CCS)	21	31,21±1,98 p ₄₋₇ <0,001 p ₄₋₁ <0,001	13,16±3,00 p ₄₋₇ <0,001 p ₄₋₁ <0,001	16,77±1,11 p ₄₋₇ <0,001 p ₄₋₁ <0,02
V (patients with clasp prostheses)	10	13,3±0,79 p ₅₋₇ <0,001 p ₅₋₂ <0,001 p ₅₋₄ <0,001	6,99±1,93 p ₅₋₇ <0,001 p ₅₋₂ <0,001 p ₅₋₄ <0,5	11,72±0,75 p ₅₋₇ <0,001 p ₅₋₂ <0,001 p ₅₋₄ <0,5
VI (patients with removable lamellar dentures from methyl methacrylate)	10	12,35±2,42 p ₆₋₇ <0,001 p ₆₋₃ <0,001 p ₆₋₄ <0,001 p ₆₋₅ >0,5	5,08±0,59 p ₆₋₇ <0,001 p ₆₋₃ <0,001 p ₆₋₄ <0,02 p ₆₋₅ <0,5	6,75±0,81 p ₆₋₇ <0,001 p ₆₋₃ <0,001 p ₆₋₄ <0,001 p ₆₋₅ <0,001
VII (healthy with intact dentition)	21	60,92±4,44	50,02±2,02	30,74±1,43

In the mixed saliva of group IV patients, the GPO and GR activity decreased by 66.0% ($p < 0.001$) and 21.8% ($p < 0.02$), as compared with the corresponding parameters before prosthetics. In patients of group V, the GPO activity was lower by 73.0% ($p < 0.001$), and GR - by 43.3% ($p < 0.001$) compared with the indicators in group II. When removable lamellar prostheses were used for the treatment of adentia, the general tendency to inhibition of the activity of glutathione-dependent enzymes of antiradical protection of the oral cavity, observed in clinical groups IV and V, remained.

The GPO activity in the VI - group was lower by 75.7% ($p < 0.001$) compared with the data in the III - group.

The GR activity when wearing lamellar prostheses was 64.1% lower ($p < 0.001$) compared with the data in group III. Thus, in gastric cancer patients with secondary adentia, both before prosthetics and after the use of fixed and removable orthopedic structures, there are significant disturbances in the exchange of one of the main cellular antioxidants, reduced glutathione, which is capable of both independently reducing reactive oxygen species and, together with HPO, to catalyze recovery of hydrogen peroxide and organic peroxides.

Apparently, the oxidation of functionally important thiol groups of GSH occurs through the direct action of oxidizing agents with thiolooprivative action on them. In edentulous conditions without prosthetics, as well as during prosthetics with fixed bridges, the most likely mechanism for reducing the content of reduced glutathione in gastric cancer of patients is the accumulation of metal ions with variable valence (for example, ions of iron, cobalt, nickel, chromium) discovered by a number of authors [6, 8]. The decrease in the concentration of GSH in OC was facilitated by a decrease in the activity of the GR-enzyme, which regenerates reduced glutathione.

When removable lamellar prostheses are used for prosthetics, the leading mechanism contributing to a decrease in the GSH content in the gastric cancer of patients, in our opinion, is the presence of residual monomer in the prosthesis - a methyl methacrylate

residue that has not undergone a polymerization reaction, which is a free radical by its chemical nature.

Clasp dentures used in this study were made of methyl methacrylate, imitating the shape of the crown of missing teeth, and a metal arch connecting the prosthesis into a single whole, and therefore in patients of the V - clinical group, both described mechanisms of activation of free radical oxidation of biomolecules took place.

A decrease in the activity of GPO and GR in gastric cancer of patients whose dentition defects were replaced by fixed and removable prostheses is apparently associated with the oxidative modification of the functional groups of enzymes, which occurs under the action of an excessive amount of reactive oxygen species and free radicals. The resulting conformational rearrangements of the enzyme molecule, the dissociation of proteins into subunits, as well as an increase in the rate of their degradation can be the cause of the phenomenon we observe.

The described metabolic disorders that occur in the OC of edentulous patients both before and after dental prosthetics indicate the formation of oxidative stress in the patient's body and require timely correction with antioxidant drugs.

V. Conclusion

Research has shown the obvious advantages of producing cobalt and chromium based alloys in granular form. The new form of release of the KHS alloy in the form of granules makes it possible to successfully use it in people with adverse environmental factors.

Alloy KHS with the release of workpieces in the form of granules is one of the construction materials that allows it to be used as a means of preventing complications when using metal inclusions in persons employed in metallurgical production.

A personalized approach is needed to the choice of materials for the manufacture of dentures in patients, especially those who work with adverse physical and chemical factors.

Thus, studies have shown the obvious advantages of producing cobalt and chromium-based alloys in the form of granules. According to X-ray

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microanalysis data, the greatest chemical heterogeneity is observed in billets in the form of rods, the same patterns are noted in metallographic research.

Clinical use of the KHS alloy, produced in the form of granules, showed its good tolerance by patients. The use of dental alloy work pieces in the form of granules is a measure of preventing the development of galvanic processes and corrosion of the KHS.

Dental alloy manufacturers should switch to a new form of production of metal alloy billets in the form of granules. As a result of the study, the expert-diagnostic complex "Lira-100" provides high-precision diagnostics of the BEMR parameters of living organ tissues and determines with high accuracy the presence of pathological processes in the OC with real microcirculation and the intensity of metabolic processes.

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