

Clinical and Biochemical Parameters of Patients with Oral Galvanosis

Aleksandr V. Tsimbalistov¹, Ekaterina S. Mikhailova², Irina V. Voytiatskaya¹, Irina. P. Ryzhova¹, Aleksandr A. Ponomarev¹

Aleksandr V. Tsimbalistov¹, Ekaterina S. Mikhailova², Irina V. Voytiatskaya¹, Irina. P. Ryzhova¹, Aleksandr A. Ponomarev¹

¹Belgorod State University, Belgorod, Russia

²Saint Petersburg State University, St. Petersburg, Russia, Belgorod State University, Russia, Belgorod

Pobeda St, Belgorod, 308015, Russia

E-mail: tsimbalistov@bsu.edu.ru

Correspondence:

Andrey V. Tsimbalistov

Belgorod State University, Belgorod, Russia

E-mail: tsimbalistov@bsu.edu.ru

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ABSTRACT

The clinical and biochemical parameters of patients with oral galvanosis were studied. A comprehensive examination of patients with galvanosis, which included an assessment of dental and somatic status, as well as a study of the content of low- and medium-molecular-weight substances (LMMWSs) in plasma, erythrocytes and mixed saliva was held. Patients with galvanosis who were also likely to have diseases of the digestive system, diseases of the circulatory system, diseases of the nervous system prevail among comorbidities. Consequently, the course of the underlying disease in the examined patients is complicated by concomitant somatic pathology due to the observed polymorbidity. The absolute values of the current value recorded in the oral cavity do not correlate with the subjective and objective manifestations of galvanosis. A positive average correlation was found between the severity of the development of galvanosis and the level of impedance in the oral cavity ($r=0.573$, $p<0.001$). The high level of LMMWSs in the blood (22.12 ± 0.77 c.u.) and mixed saliva (29.88 ± 0.62 c.u.) in patients with galvanosis indicates endogenous intoxication resulting from the impairment of many organs and systems, which is confirmed by the history and examination data. The placement of dental material into the oral cavity increases the degree of toxic load and has a negative impact on the surrounding tissues and the body as a whole.

Keywords: galvanosis, burning mouth syndrome, intolerance to dental materials, metal alloy, substances of low and medium molecular weight (LMMWSs).

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INTRODUCTION

A serious disadvantage of most metal alloys used in dentistry is the lack of chemical stability in the liquid environment of the oral cavity (Kettelarj et al. 2014; Sutov et al. 2004). This interaction is known as the corrosion process. Intensive and long-term corrosion leads to the destruction of the surface, violation of the integrity of dental prostheses (Sousa et al. 2014). Corrosion products diffuse into the tooth tissue, penetrate into the oral mucosa, compact and spongy substance of the mandible. The increase in the concentration of a number of trace elements in saliva, gastric juice, blood and urine was marked (Garhammer et al. 2004; Al-Imam et al. 2016; Sarafraz et al. 2018; Ece & Tünay 2018).

The problem of galvanosis covers a wide range of issues related to the effect of various metal alloys on the tissues and organs of the oral cavity, the human body, on the one hand, and the influence of the patient's biological environment on dental prostheses, on the other hand (Denizoglu et al. 2004; Alp et al. 2018; Poniakina et al. 2009; Banchenko et al. 2012; Turdean, et al. 2019).

The mucous membrane of the mouth is functionally connected with various organs and systems of the body, in connection with which the pathology of other organs and systems affects its functioning and metabolic state. The role of concomitant somatic pathology in the development of intolerance to dental materials of electrochemical nature has been recognized (Lebedev et al. 2013; Mikhailova 2019; Velichko & Yashchikovskiy 2011).

The term “metabolic status” implies a kind of balance of any substances in the body, that is the dynamic balance of anabolic and catabolic processes (Malakhova & Zubatkina 2004). The action of any aggressive factor forms a certain metabolic response of the body, which is understood as the combination of biological reactions, the speed and direction of their flow. It is important to note that their focus can be either towards the strengthening of metabolic processes, or towards a decrease. In this regard, the determination of the metabolic status of the content of low- and medium-molecular-weight substances (LMMWSs) of biological fluids and the subsequent registration of its possible changes can clearly reflect the state of metabolism at the time of registration and determine the shift of metabolic processes, which occurs as a result of compensation of negative factors, adaptation or development of the disease (Petrosyan et al. 2018).

In the pathogenesis of pathological processes of maxillofacial localization, a significant role is played by the syndrome of endogenous intoxication of a complex etiology, including diseases of the oral cavity, the toxic-allergic effects of dental materials and somatic pathology (Petrosyan et al. 2018). Numerous clinical and experimental studies have established that endogenous intoxication occurs in a wide variety of diseases and has no specific manifestations (Kelina et al. 2012; Zabelin et al. 1994).

The presence of a chemically unstable metal alloy in the oral cavity can be a provoking and / or aggravating factor in the development of intoxication of the patient's body, which will be reflected in the content of LMMWSs in biological

fluids of the body. Therefore, the study of clinical and biochemical parameters of dental patients with oral galvanosis is a promising direction in dentistry and will allow you to choose pathogenetically based tactics for the management of this group of patients.

The purpose of this study is to investigate the clinical and biochemical parameters of patients with oral galvanosis.

MATERIALS AND METHODS

Under the supervision there were 223 patients with galvanosis (group III) aged from 35 to 77 years. The follow-up period was 15.2 ± 1.4 years. All patients had previously undergone orthopedic treatment in order to replace dentition defects with non-removable prosthetics, which, from the patients' point of view, was the cause for the appearance of uncomfortable sensations and intolerance. Group II consisted of 124 patients aged from 38 to 76 with non-removable prosthetics in the oral cavity, made, among other things, of metal alloys, without complaints and intolerance to dental materials. I (control) group is represented by 40 healthy people without prosthetics in the oral cavity.

Clinical examination of patients included a thorough collection of life anamnesis and disease. Particular attention was paid to the assessment of dental and somatic status with the measurement of impedance in the oral cavity and the magnitude of the galvanic current.

A study was conducted on the content of LMMWSs in plasma, erythrocytes and mixed saliva in three groups of patients using an SF-2000 spectrophotometer for liquid and solid transparent samples combined with a personal

computer. Blood sampling was performed in the first half of the day on an empty stomach from the cubital vein. A mixed saliva sampling was carried out in the morning before the meal. Fifteen minutes before the mouth was rinsed with a glass of distilled water. The collection of mixed saliva began ten minutes after rinsing into a sterile tube and lasted fifteen minutes. The resulting mixed saliva was filtered using funnels with Shot filters and a system of ground flasks. Deposition of macromolecular proteins of mixed saliva and blood was performed with a solution of trichloroacetic acid with a concentration of 150 g / l in a 1: 2 ratio. The obtained samples were centrifuged after five minutes at 3000 rpm for twenty minutes. The resulting supernatants were diluted with distilled water in a ratio of 1: 9 and photometric in parallel with the control solutions. The final result was calculated by integral measurement of the area of the figure formed by the abscissa axis and the obtained extinction values for each type of definition (mixed saliva, plasma and erythrocytes).

Statistical data processing on a personal computer was carried out using the STATISTICA for Windows software system (version 10.0). The differences were regarded as significant at $p < 0.001-0.05$.

RESULTS AND DISCUSSION

The level of individual tolerance to dental materials is a variable value, changing under the influence of common diseases, hormonal changes, aging processes. Women of middle age (45-59 years) are more often diagnosed with galvanosis. Analysis of the frequency of occurrence of galvanosis is presented in Figure 1.

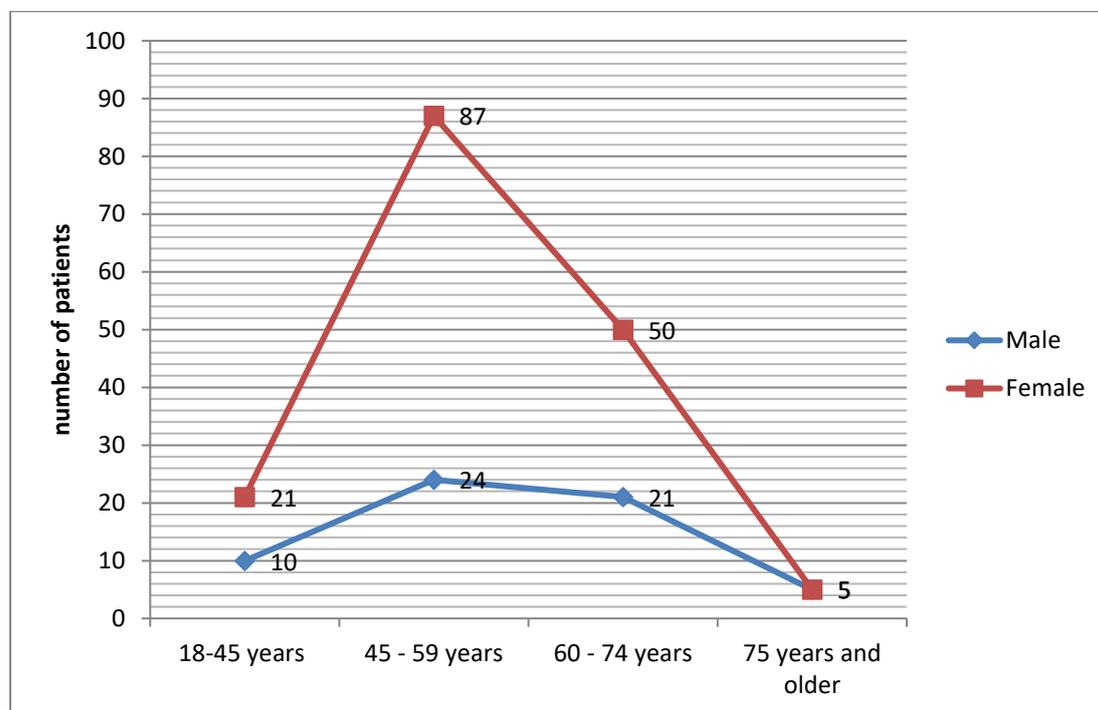


Figure 1: The distribution of patients with galvanosis by gender and age.

Analysis of the concomitant diseases of patients with galvanosis showed a high incidence of diseases of the digestive system (K00-K93) (54.71%, $\chi^2=17.729$; $p<0.001$;

$r=0.282$; $OR=2.29$ [1.55;3.39]), including gastritis and duodenitis (K29) ($\chi^2=28.881$; $p<0.001$; $r=0.355$; $OR=3.24$ [2.09;5.01]). There was a high statistically significant

incidence of diseases characterized by high blood pressure in patients with galvanosis (I10-I15) (32.73%, $\chi^2=6.987$; $p=0.009$; $r=0.179$; $OR=1.79$ [1.16;2.77]), as well as diseases of the nervous system (18.83%, $\chi^2=6.38$; $p=0.012$; $r=0.171$; $OR=5.64$ [3.33;9.53]).

Concomitant diseases in various combinations were detected in patients of groups II and III. As a rule, one patient with galvanosis has 2-3 nosological forms of diseases of various organs and systems or a combination of them (2.68 ± 0.11), whereas in group II patients – 1-2 diseases (1.27 ± 0.13) ($p<0.001$).

The appearance of complaints and clinical manifestations of patients with galvanosis is not a direct result of the electroplating process, but a reaction to it, which occurs as a result of a change in the body's sensitivity to galvanic current. Galvanic current occurs immediately after the placement of alloys with different electrochemical activity into the oral cavity. However, the clinical development of galvanosis arises later, which indicates the reactive nature of this pathological condition. The appearance of the disease is usually delayed from the moment of implantation of prosthetics, and this period can be quite long (Fig. 2).

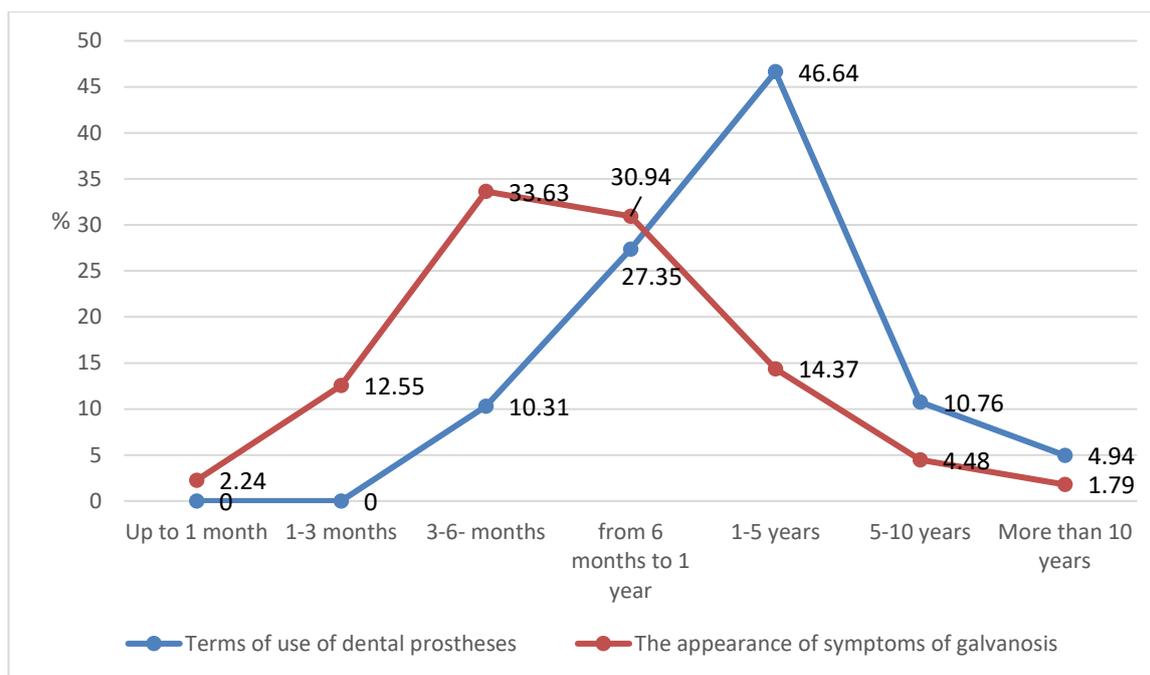


Figure 2: The ratio of terms of use of the latest prosthetics/ terms of symptoms of galvanosis.

Each subsequent non-removable prosthetic leads to the next, sometimes aggressive effect of the dental material on the tissues and organs of the oral cavity, the organism as a whole. In such conditions, the likelihood of symptoms of galvanosis will be determined by the reactivity of the human body, on the one hand, and quality, compliance with the technology of manufacturing non-removable prosthetics, on the other hand. The appearance of intolerance symptoms, on average, occurred after the third prosthetics (3.67 ± 0.08). However, data analysis revealed no significant correlation between the number of episodes of prosthetics and the appearance of symptoms of galvanosis.

The main complaints of patients with galvanosis were: burning of the oral mucosa (98.21%), dryness of the oral mucosa (74.44%), change in taste (74.44%) and taste of metal, bitterness, acid in the oral cavity (84.75%). Edema of the oral mucosa was indicated by 17.49% of patients, increased salivation - 13.9% of patients, deterioration of general well-being - 6.73% and exacerbation of concomitant somatic pathology - 5.38%. An objective examination of only 10.3% of the patients examined with galvanosis revealed dryness of the oral mucosa. In other cases, apparently, there were paresthetic complaints of a feeling of dryness without its external clinical manifestations.

Disturbance of taste sensations, the appearance of metal taste, bitterness or acids indicate intensely occurring electrochemical processes between metal alloys in the oral cavity.

Most of the patients with galvanosis experienced the burning sensation of the oral mucosa (83.35%), decreased or disappeared during the meal. Quite often, a burning sensation occurred only at the point of contact of the mucous membrane with the non-removable prosthetic (79.82%). In 55.07% of cases, after the removal of the prosthetics, which caused the appearance of symptoms of galvanosis, paresthetic burning sensations persisted. Thus, prosthetics for these patients was a provoking factor contributing to the development of burning mouth syndrome. An increase in the duration of stay in the oral cavity of the prosthetics, which causes the appearance of symptoms of galvanosis, leads to a longer persistence of burning sensation of the oral mucosa ($r = 0.688$, $p < 0.001$).

In 69.95% of observations of patients with galvanosis, the oral mucosa was without visible pathological changes. Lichenoid changes of the oral mucosa were detected in 20.18% of cases, catarrhal inflammation of the oral mucosa in 18.83% of cases, swelling of the oral mucosa in 4.93% and petechial hemorrhages in 2.69% of cases.

The analysis of indicators of electrochemical processes in the oral cavity with different combinations of metal alloys is carried out (Table 1, 2).

Table 1: Measurement of impedance in the oral cavity of patients with galvanosis (group III) and group II patients

Combination of metal alloys in patients with galvanosis	Patients with galvanosis (group III) (impedance level, c.u./Cv, %)	Group II patients (impedance level, c.u./Cv, %)	Combination of metal alloys in group II patients	P
steel + steel(n=32)	24.25±1.22 Cv 6.16%	288.53±1.27 Cv 2.44%	steel + steel(n=17)	<0.001
steel + steel with NT (n=49)	29.02±0.86 Cv 4.81%	282.43±2.31 Cv 4.28%	steel + steel with NT (n=8)	<0.001
steel with NT + steel with NT (n=53)	21.92±0.79 Cv 3.22%	272.44±1.53 Cv 3.29%	steel with NT + steel with NT (n=7)	<0.001
CCA + CCA (n=0)	0	316.91±1.12 Cv 3.35%	CCA + CCA (n=32)	-
CCA + steel (n=12)	38.91±1.43 Cv 4.52%	306.42±2.21 Cv 3.36%	CCA + steel (n=8)	<0.001
CCA+ steel with NT (n=24)	28.03±0.82 Cv 3.73%	0	CCA+ steel with NT (n=0)	-
goldalloy+ steel (n=8)	32.37±1.38 Cv 3.32%	296.6±2.14 Cv 6.3%	goldalloy+ steel (n=7)	<0.001
gold alloy + gold alloy (n=0)	0	332.22±1.65 Cv 3.52%	gold alloy + gold alloy (n=8)	-
NCA+ NCA(n=0)	0	321.17±1.53 Cv 2.88%	NCA + NCA(n=21)	-
NCA+ steel (n=17)	30.33±1.64 Cv 6.54%	0	NCA + steel (n=0)	-
NCA+ steel with NT (n=18)	22.94±0.55 Cv 5.06%	0	CA + steel with NT (n=0)	-
SPA + steel (n=19)	40.16±0.38 Cv 3.66%	0	SPA + steel (n=0)	-
SPA + SPA (n=0)	0	330.66±3.51 Cv 5.75%	SPA + SPA(n=7)	-

Note: NT - titanium nitride, SPA- silver-palladium alloy, CCA - cobalt-chrome alloy, NCA - nickel-chrome alloy.

In patients with galvanosis, the lowest impedance values are determined when the following metal alloys are combined in the oral cavity: steel and steel; steel with NT and steel with NT. In group II patients, there was a decrease in the impedance of various combinations of steel and steel with NT. Perhaps these patients are at risk for the occurrence galvanosis. When comparing 2 groups of patients, the data obtained had statistical significance ($p < 0.001$). A coefficient of variation of less than 10% indicates a small degree of data

dispersion. Thus, the average values of the impedance are significant and represent a homogeneous population.

Analysis of data obtained when measuring the values of galvanic current showed that the highest values were found in patients with a combination of steel and steel with HT in both groups. In patients with galvanosis, the level of galvanic currents in the oral cavity is significantly increased ($p < 0.001$) relative to group II data.

Table 2: Measurement of the value of the galvanic current in the oral cavity of patients with galvanosis (group III) and group II patients

Combination of metal alloys in patients with galvanosis	Patients with galvanosis (group III) (value of the galvanic current, mkA/Cv, %)	Group II patients (value of the galvanic current, mkA/Cv, %)	Combination of metal alloys in group II patients	P
steel + steel(n=32)	20.97±1.52 Cv 41.0%	4.76±0.56 Cv 47.24%	steel + steel(n=17)	<0.001
steel + steel with NT (n=49)	38.98±2.12 Cv 38.03%	6.75±0.98 Cv 38.59%	steel + steel with NT (n=8)	<0.001
steel with NT + steel with NT (n=53)	32.94±2.34 Cv 51.74%	6.71±1.39 Cv 50.66%	steel with NT + steel with NT (n=7)	<0.001
CCA + CCA (n=0)	0	3.19±0.33 Cv 59.44%	CCA + CCA (n=32)	-
CCA + steel (n=12)	14.08±1.5 Cv 35.57%	4.88±1.01 Cv 54.2%	CCA + steel (n=8)	<0.001

CCA+ steel with NT (n=24)	25.58±2.14 Cv 40.18%	0	CCA+ steel with NT (n=0)	-
goldalloy+ steel (n=8)	14.5±2.75 Cv 50.14%	3.0±0.61 Cv 57.74%	goldalloy+ steel (n=7)	<0.001
gold alloy + gold alloy (n=0)	0	2.38±0.4 Cv 44.66%	gold alloy + gold alloy (n=8)	-
NCA + NCA(n=0)	0	3.9±0.42 Cv 48.53%	NCA + NCA(n=21)	-
NCA + steel (n=17)	10.0±1.03 Cv 30.91%	0	NCA + steel (n=0)	-
NCA + steel with NT (n=18)	15.5±1.71 Cv 45.47%	0	CA + steel with NT (n=0)	-
SPA + steel (n=19)	12.0±1.63 Cv 44.95%	0	SPA + steel (n=0)	-
SPA + SPA (n=0)	0	2.43±0.4 Cv 40.18%	SPA + SPA (n=7)	-

Note: NT - titanium nitride, SPA- silver-palladium alloy, CCA - cobalt-chrome alloy, NCA - nickel-chrome alloy.

However, the values of the coefficient of variation indicate that the sample is heterogeneous and that there is a significant variation in the attribute values in the aggregate. When estimating the value of the galvanic current using an ammeter, we get a significant variation in values. It should be noted that the absolute values of the current value do not correlate with the severity of the clinical picture of galvanosis. A positive average correlation was found between the severity of the clinical picture of galvanosis and the level of impedance in the oral cavity ($r=0.573$, $p<0.001$).

There is an opinion that mixed saliva in normal conditions of a healthy organism reflects the level and composition of

substances of low and average molecular weight in plasma, since it is formed from blood. The pathology of the oral cavity makes its own adjustments to the composition and concentration of LMMWSs as a result of the receipt of these substances from the lesion.

The study of LMMWSs showed the presence of statistically significant differences between the values of this parameter in plasma and mixed saliva in patients of groups I and III, II and III (Table3). Patients with galvanosis, had the level of LMMWSs in plasma and mixed saliva significantly higher compared to the data of groups I and II.

Table 3: The content of LMMWSs in patients of groups I, II and III

Parameter	Group I (M±m)	Group II (M±m)	Group III (M±m)	P1	P2	P3
LMMWSs in plasma(c.u.)	15.12±1.24	18.51±1.22	22.12±0.77	0.052	<0.001	0.013
LMMWSs in erythrocytes(c.u.)	30.22±0.88	31.54±0.91	32.73±0.99	0.298	0.059	0.376
LMMWSs in mixed saliva(c.u.)	17.42±0.93	19.93±0.94	29.88±0.62	0.058	<0.001	<0.001

Note: P1 – level of significance of differences between group I and group II; P2 – level of significance of differences between group I and group III; P3 – level of significance of differences between group II and group III

The assessment of the metabolic status of patients with galvanosis on the content of LMMWSs corresponds to the general clinical somatic assessment of the state of the organs and systems of patients. A direct correlation was found between the values of LMMWSs in the plasma and the level of somatic pathology of the patients examined with galvanosis ($r = 0.612$, $p < 0.001$).

The content of LMMWSs in the mixed saliva increases, which may indicate the activity of electrochemical processes, the breakdown of high-molecular substances contained in saliva, as well as the release of various regulatory peptides of saliva, changes in the content of local immuno reactivity factors.

Consequently, the high content of LMMWSs in the blood and mixed saliva in patients with galvanosis indicates endogenous intoxication resulting in the impairment of

many organs and systems, which is confirmed by anamnesis and examination data, due to the introduction of dental material that increases the degree of toxic load, has a negative impact on the surrounding tissues and the body as a whole, causing a response, expressed in enhancement of destructive processes.

CONCLUSION

Thus, galvanosis is 2.7 times more often diagnosed in women than in men. The peak incidence of galvanosis accounts for middle-aged people. Patients with galvanosis who were also likely to have diseases of the digestive system, diseases of the circulatory system, diseases of the nervous system prevail among comorbidities. Consequently, the course of the underlying disease in the examined patients is complicated by concomitant somatic pathology due to the observed polymorbidity.

Quite often, the elimination of the local etiological factor of patients with galvanosis does not lead to the complete disappearance of burning sensation of the oral mucosa, which indicates the leading role of local factors in the development of the burning mouth syndrome. It should also be noted that the severity of paresthetic sensations in galvanosis directly depends on the number of background diseases in one patient ($r = 0.504$, $p < 0.001$), which makes it difficult to choose the right therapeutic measures and adversely affects the results of treatment, since the elimination of the local cause often does not leads to the disappearance of burning sensation of the oral mucosa.

The absence of specific manifestations of galvanosis, the prevalence of subjective symptoms complicate the differential diagnosis of this symptom complex from all other similar clinical conditions.

The absolute values of the current value recorded in the oral cavity do not correlate with the subjective and objective manifestations of galvanosis. A positive average correlation was found between the severity of the development of galvanosis and the level of impedance in the oral cavity.

The level of LMMWSs in plasma and mixed saliva of patients with galvanosis is significantly higher compared to patients without complaints and intolerance to dental materials. Therefore, the placement of a dental material into the oral cavity that activates electrochemical processes with the development of galvanosis of patients with a burdened somatic history leads to an even greater increase in the level of LMMWSs in biological fluids of the body and, accordingly, the degree of intoxication of the body. This fact should be taken into account when planning and implementing a comprehensive treatment plan for patients with galvanosis.

CONFLICT OF INTEREST

None

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