

THE STUDY OF THE ELECTROCHEMICAL POTENTIALS OF METAL STRUCTURES IN THE ORAL CAVITY IN DISEASES OF THE ORAL MUCOSA.

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ABSTRACT

The aim of the study was to research the electrochemical potentials in the oral cavity in various oral mucosa diseases.

On the Department of Therapeutic Dentistry in I.M. Sechenov First Moscow State Medical university was examined 342 patients, aged from 36 to 78 years old with suspected development of galvanic syndrome in oral cavity. Women accounted for 61% (207 people), men - 39% (135 people). 138 patients were referred to us with a diagnosis of glossalgia and burning mouth syndrome, 54 patients with limited hyperkeratosis of the oral mucosa, 45 patients with a diagnosis of verrucous leukoplakia, 63 patients with a diagnosis of lichen planus (erosive and ulcerative form) and 42 patients with erythema migrans. All patients aimed at studying the electrochemical potential had various prosthetic metal constructions in oral cavity: crowns, bugel denture, implants, inlays, metal pins. As a measuring device, when determining the electrochemical potentials of the oral cavity, a millivoltmeter with high input resistance (more than 20 mega ohm), sensitivity above 200 mV, protection from external interference and autonomous power supply was used.

As a result of the study, it was established that the determination of the electrochemical potentials of metal structures located in the oral cavity allows confirming or refuting the presence of galvanic syndrome in various oral mucosa diseases. In patients diagnosed with glossalgia, burning mouth syndrome and erythema migrans, a high difference in the electrochemical potentials of various metal structures was observed in only 50% of the patients examined. In erosive and ulcerative lichen planus, verrucous leukoplakia and limited mucosal hyperkeratosis, the number of patients who had confirmed galvanic syndrome, was above 70%.

KEYWORDS: *dentistry, galvanic syndrome, oral mucosa diseases, lichen planus, leukoplakia, hyperkeratosis.*

INTRODUCTION.

Galvanic syndrome is a complex of symptoms due to the presence of galvanic current in the oral cavity. The widespread use of various metals and their alloys in dentistry has led to the emergence of new problems and diseases, which include the development of galvanic syndrome. This syn-

drome is manifested by the following symptoms: metallic taste in the mouth, sense of acid, perversion of taste, and a burning sensation of the tongue [Gozhaya L, 2000; Lebedev K et al., 2010; Makarenko N, Arakelyan M, 2017]. Irritability, headaches, weakness, and dry mouth can occur. As a result of chronic irritation with electric current, the resistance of tissues decreases, the microbial landscape of the oral cavity changes, glossalgia, burning mouth syndrome and oral mucosa diseases develop, accompanied by erosion or hyperkeratosis [Lebedev K.A. et al., 2012; Lebedev K, Ponyakina I, 2014].

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The cause of galvanic current is the presence of dissimilar metals in the oral cavity (crowns, implants, inserts, pins) it can occur in the vast majority of patients. It is known for electrochemistry in which every metal immersed in an electrolyte solution acquires a certain potential peculiar only to it. If there are alloys of metals with different electrochemical potentials in the oral cavity, then galvanic currents begin to flow between these metals. The role of electrolyte in this case is performed by saliva [Ponyakina I et al., 2009].

High prevalence of galvanic syndrome in oral cavity in modern dentistry requires effective prevention, diagnosis and treatment, which demonstrates the relevance of current study. It is practically impossible to register the galvanic current, which occurs when there are metals with different electrochemical potentials in the oral cavity, due to its volume distribution in soft tissues. In this regard, the measurement of the strength of the current in the oral cavity does not represent a great diagnostic value due to the presence of leakage currents, which leads to serious measurement errors.

The presence of galvanic currents in the oral cavity can only be determined indirectly by measuring the electrochemical potentials of various metal structures and inclusions in the oral cavity [Gorina E, 2016; Volkov A et al., 2016; Makeeva I et al., 2017]. In this case, the greater the difference in the electrochemical potentials of various metal structures and inclusions, the higher the electromotive force and the likelihood of galvanic currents. According to the literature, the probability of galvanic currents appears when the difference in electrochemical potentials between different metal structures is at least 60 mV [Lebedev K, Ponyakina I, 2014].

It should be noted that prosthetics often create conditions conducive to galvanic currents in the oral cavity. For example, when in the mouth of permanent metal dentures with support on teeth with metal inserts and/or dental implants, since these metal structures are represented by several types of metals or alloys. After the appearance of metal structures and inclusions in the oral cavity with the difference of electrochemical potentials exceeding the threshold values, signs of galvanic syndrome development can begin to appear from 1-3 weeks to 2-3 months and more after the appearance of

“galvanic pair” in the mouth. Long-term irritation of oral mucosa by galvanic current can contribute to the development of mucous membrane diseases, including pre-cancer diseases, such as verrucous form of leukoplakia, erosive-ulcerative and hyperkeratotic form of red flat deprivation, limited hyperkeratosis. There is also evidence in the literature that electrogalvanic microcurrents can lead to the development of malignant neoplasms [Volkov A. et al., 2016]. The electrochemical potentials of the oral cavity are investigated in the presence of suspected galvanic syndrome. Without conducting this study it is almost impossible to clarify and correctly make a diagnosis.

Some authors are argued that only if a large difference in potentials of metal structures in the oral cavity is detected in patients and if symptoms characteristic of galvanic syndrome are present can we talk about making the correct diagnosis [Lebedev K, Ponyakina I, 2014]. There are no absolute contraindications for measuring the electrochemical potentials of the oral cavity.

Aims. The study of electrochemical potentials in the oral cavity in various oral mucosa diseases.

MATERIALS AND METHODS:

On the Department of Therapeutic Dentistry in IM Sechenov First Moscow State Medical university was examined 342 patients aged from 36 to 78 years old with suspected development of galvanic syndrome in oral cavity. Women accounted for 61% (207 people), men - 39% (135 people). 138 patients were referred to us with a diagnosis of glossalgia and burning mouth syndrome, 54 patients with limited hyperkeratosis of the mucous membrane, 45 patients with a diagnosis of verrucous leukoplakia, 63 patients with a diagnosis of lichen planus (erosive and ulcerative form) and 42 patients with erythema migrans. All patients aimed at studying the electrochemical potential had various prosthetic metal constructions in oral cavity: crowns, bugel denture, implants, inlays, metal pins. As a measuring device, when determining the electrochemical potentials of the oral cavity, a millivoltmeter with high input resistance (more than 20 mega ohm), sensitivity above 200 mV, protection from external interference and autonomous power supply was used [Makeeva I et al., 2017].

In the study, was used two electrodes passive

and active. A passive electrode is an electrode that is non-polarizable during the study, and its potential must be stable over time. A neutral silver chloride electrode was used as a passive electrode.

The active electrode was an inert metal electrode made of 900 purity of gold. The change in the potential of the active electrode is determined by the level of redox processes in those tissues where the active electrode is placed.

The study was performed in a dental chair, in the sitting position of the patient. Before the study, the patient was asked to rinse the mouth with distilled water. Between the skin and the passive electrode was placed a gauze wad moistened with physiologic saline. A passive electrode was placed on the skin of the inner side of the arm wrist. The active electrode consistently touched various metal structures and inclusions in the oral cavity. At each test site, the active electrode was fixed for 10–15 seconds (until the instrument readings stabilized). At the same time, using a measuring device, the potential difference in *mV* between the passive electrode placed on the arm wrist and the active electrode, which was placed sequentially on various metal structures and inclusions in the oral cavity, was determined.

RESULTS

Of the 342 patients examined, 228 (66%) had a high difference in electrochemical potentials of various metal structures in the oral cavity, which indicated the possibility of the appearance of galvanic currents in the oral cavity and the development of galvanic syndrome.

Out of 138 patients referred with glossalgia and burning mouth syndrome, in 90 patients burning mouth syndrome or glossalgia was combined with the subjective sensations of “dry mouth”. In 69 patients, which accounted for 50% of this group, a high difference in electrochemical potentials of metal structures was determined - from 60 to 200 *mV* (on average from 80 to 150 *mV*).

In 33 (73%) of 45 patients with a verrucous form of leukoplakia, a high difference in the electrochemical potentials of metal structures was found - from 60 to 250 *mV* (average 100–200 *mV*). All 54 patients with limited hyperkeratosis of the oral mucosa showed a high difference in electrochemical potentials of metal structures from 120 to 250 *mV*.

With the erosive form of lichen planus in 51 patients out of 63, which accounted for 73%, a high difference in the electrochemical potentials of various metal structures was found - from 100 to 120 *mV*. Of the 42 patients diagnosed with erythema migrans in 21, which accounted for 50%, a large difference in the electrochemical potentials of metal structures was determined 100–120 *mV*.

DISCUSSION

Studies on the galvanic syndrome interested dentists and were carried out in a historical aspect for a long time [Venugopalan R, Lucas L, 1998; Brailo V et al., 2006]. Materials and alloys are rapidly developing in prosthetic dentistry. However, despite the great interest in this topic, there are currently more questions than answers [Stawiński K, Wójciak L, 1966; Korraah A et al., 2012; Makeeva I et al., 2017]. A number of authors consider that a gastroenterologist and a mental specialist should treat a patients with glossalgia [Makeeva I. et al., 2017]. But, in our study, patients with glossalgia in 50% of cases determined the high difference in electrochemical potentials of metal structures, which suggests that this factor cannot be disregarded. At the same time, the data of our study are fully consistent with [Herrström P, Högstedt B, 2017] and [Podzimek S, 2013; Mohammed F, Fairizekhan A, 2017], which concluded that the phenomena of galvanic syndrome in the mouth induce subcellular changes in precancerous cells during leukoplakia in vitro and simulate some morphological features of these cells in vivo. A number of authors note the importance of the microbial factor in galvanic syndrome [Balasubramaniam R et al., 2009], and of course, since the end of the 1990s, materials research has been carried out and acceptable combinations of metals have been developed for use as clinical guidelines in prosthetic dentistry [Koh I et al., 2008]. The fact that the problem of galvanic syndrome exists must be remembered when treating patients with a dental profile [Stawiński K, Wójciak L, 1966]. And also, to strive to improve the methods of diagnosis and prevention of such conditions, which was the subject of our research.

CONCLUSION

Thus, as a result of the conducted research, it was established that the determination of the electrochemical potentials of metal structures located in the oral cavity, allows confirming or refuting the presence of galvanic syndrome in various oral mucosa diseases. In patients diagnosed with glossalgia, burning mouth syndrome and erythema migrans, a high difference in the electrochemical potentials of various metal structures was observed in only 50% of the patients examined. In erosive and ulcerative lichen planus, verrucous leukoplakia

and limited mucosal hyperkeratosis, the number of patients who had confirmed galvanic syndrome, was above 70%.

If there is a large difference in electrochemical potentials between metal structures in the oral cavity, a galvanic current appears and a galvanic syndrome develops. Considering that diseases of the oral mucosa have a multifactorial etiopathogenesis, the data of our study indicate that galvanic syndrome may be one of the factors provoking the development and exacerbation of diseases of the oral mucosa.

REFERENCES

1. Balasubramaniam R, Klasser GD, Delcanho R. Separating oral burning from burning mouth syndrome: unravelling a diagnostic enigma. *Aust Dent J.* 2009; 54(4): 293-299.
2. Brailo V, Vučičević-Boras V, Alajbeg IZ, Alajbeg I, Lukenda J, Aeurković M. Oral burning symptoms and burning mouth syndrome-significance of different variables in 150 patients. *Med Oral Patol Oral Cir Bucal.* 2006; 11 (3): 252-255.
3. Gozhaya LD [Allergic and toxicological stomatitis caused by materials of dentures] [Published in Russian]. Textbook of methodics for dentists. M.(Moscow) 2000; 31.
4. Gorina ER [Improving the methods of diagnosing the condition of the oral mucosa in various diseases] [Published in Russian]. Author's abstract M. (Moscow). 2016; 25
5. Herrström P, Högstedt B. Clinical study of oral galvanism: no evidence of toxic mercury exposure but anxiety disorder an important background factor. *Scand J Dent Res.* 1993;101(4):232-7.
6. Koh I, Oshida Y, Andres CJ, Gregory RL. Effect of surface area ratios and bacteria on electrochemical behavior of galvanically coupled titanium. *Int J Prosthodont.* 2008; 21(5): 433-436.
7. Korraah A, Odenthal M, Kopp M, Vigneswaran N, Sacks PG, Dienes HP, Stützer H, Niedermeier W. Induction of apoptosis and up-regulation of cellular proliferation in oral leukoplakia cell lines inside electric field. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012; 113(5): 644-654.
8. Lebedev K.A., Mitronin A.V., Ponyakina I.D. [Intolerance to prosthetic materials] [Published in Russian]. Librokom (Moscow). 2010; 208.
9. Lebedev K.A., Ponyakina I.D. [Galvanic syndrome and chronic inflammatory processes] [Published in Russian]. Lenand (Moscow). 2014; 304.
10. Lebedev K.A., Yanushevich O.O., Mitronin A.V. [The combination of high galvanic currents and inflammation is the main cause of galvanic syndrome] [Published in Russian]. Cathedra (Moscow). 2012; 42: 30-38.
11. Makarenko N.V., Arakelyan M.G. [Galvanic syndrome as a factor aggravating the course of xerostomia] [Published in Russian]. MEDIUM AL Section 11. Dentistry (Nizhniy Novgorod). 2017; 1 (19): 292.
12. Makeeva I.M., Volkov A.G., Arakelyan M.G., Makarenko N.V. [Factors aggravating manifestations of xerostomia] [Published in Russian]. Stomatologiya (Moscow). 2017; 96 (1): 25-27.
13. Makeeva I.M., Volkov A.G., Daurova F.Yu., Dikopova N.Zh., Kozhevnikova L.A., Makeeva M.K., Talalaev E.G., Shishmareva A.L. [Apparatus treatment methods used in dentistry] [Published in Russian]. First IM Sechenov Moscow State Medical University, Medical Institute of the Peoples' Friendship University of Russia (Moscow). 2017:121.

14. Mohammed F, Fairizekhan AT. Leukoplakia, Oral. StatPearls. Treasure Island (FL): StatPearls Publishing. 2017.
15. Ponyakina I.D., Sagan L.G., Lebedev K.A. [Mechanisms of formation and flow paths of galvanic currents in the tissues and fluids of the oral cavity] [Published in Russian]. Dental. forum. 2009; 5: 22.
16. Podzimek S, Tomka M, Sommerova P, Lyuyami Y, Bartova J, Prochazkova J. Immune markers in oral discomfort patients before and after elimination of oral galvanism. Neuro Endocrinol Lett. 2013; 34(8): 802-808.
17. Stawiński K, Wójciak L. Theoretical aspects of the generation of galvanic currents in the oral cavity Pol Tyg Lek. 1966; 21(2): 64-67.
18. Venugopalan R, Lucas LC. Evaluation of restorative and implant alloys galvanically coupled to titanium. Dent Mater. 1998 Jun;14(3): 165-172.
19. Volkov A.G., Dikopova N.Zh., Makeeva I.M., Byakova S.F. [Apparatus methods for the diagnosis and treatment of periodontal and oral mucosa diseases] [Published in Russian]. M. (Moscow). 2016; 48.

