Research Article

Pathogenetic and Clinical Justification of the Use of Digital Methods to Assess Oral Homeostasis in Patients with Cardiac Arrhythmias while Taking Anticoagulants

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Abstract

The scientific work substantiates the need for the use of index indicators in assessing the dental status of the oral cavity in patients with cardiac arrhythmia against the background of taking anticoagulants based on the assessment of "ad oculum". It is objectively justified that without taking into account these indicators, the error of the method of assessing the hygienic condition of various biotopes of the oral cavity "ad oculum" is from 200 to 400 percent. Objective Raman-fluorescent medical technologies are proposed that exclude the specified measurement error "ad oculum", which are conceptually and clinically confirmed in the conditions of a dental clinic. The integral assessment of the dental status of the oral cavity, registered in the online mode, is justified. The presented medical and technical technology for assessing the homeostasis of the oral cavity and its hardware technical solution is proposed for introduction into the clinical practice of a dentist, which requires the organization, production and certification of the presented hardware and software complex.

Keywords: Oral Hygiene; Laser Diagnostics in Dentistry; Fluorescence; Raman-Fluorescent Diagnostics; Hygiene Indices; Integral Indicator of Oral Hygiene; Diseases of the Cardiovascular System; Arrhythmia; Anticoagulants; Oxygenation; Metabolism

Introduction

The problem of objective assessment of the dental status of the oral cavity in patients with cardiac arrhythmia against the background of taking anticoagulants and methods used in clinical practice to characterize it is still debatable. This is evidenced by the lack of unity and a wide variety of indices used for the above purposes, reflecting only one side of the dental status of the oral cavity [1-3]. In this case, the error of the method (not of a separate measurement, but of the method as a whole) can be more than 200% [4-6]. In the literature available to us, there is no integral index for assessing the homeostasis of the oral cavity and its hygienic status, the need for justification of which is determined by the fact that each of its separately determined index characteristics exists simultaneously, in real time and, apparently, objectively and integrally characterizes the dental status of the oral cavity as a whole. Summarizing, it can be noted that the indices used in clinical practice are mainly subjective and are determined by "ad oculum" (PHP Oral Hygiene Efficiency Index, PMA Index, Silness loe Index, Mulemann-Cowell, OHI-S, Green-Wermillion, Ulitovsky-Leontiev index) [4,7-10], which apparently, it requires their further refinement and improvement.

The presented conceptual provisions were the justification for the scientific work necessary to assess the role and significance of the above factors for the objectification of indicators of homeostasis of the oral cavity and the development of medical technology for its integral assessment.

As a working medical technology to solve this urgent problem, it is proposed to use the method of laser-fluorescent diagnostics (LFD) and Raman diagnostics (RD), which, when applied simultaneously, are collectively Raman-fluorescent diagnostics (RFD) [5,11-13].

Objective

To conduct pathogenetic and clinical substantiation of oral homeostasis indicators and to justify the use of an objective digital method of Raman-fluorescence diagnostics to assess the dental status of the oral cavity in patients with cardiac arrhythmia while taking anticoagulants, excluding the subjectivity of its indicators recorded by "ad oculum".

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Tasks

- To conduct a comparative assessment of the existing index methods of "ad oculum" and methods of Raman-fluorescence diagnostics in characterizing the effectiveness, objectivity and accuracy of assessing the hygienic condition of the oral cavity.
- To substantiate the need for the integrated application of individual methods of "ad oculum" and methods of Raman-fluorescence diagnostics to improve the objectivity and effectiveness of the assessment of the dental status of the cavity.
- To conduct a clinical approbation of the proposed complex medical technology and evaluate its objectivity and effectiveness.

Materials and Methods

In total, there were 150 patients aged 35 to 55 years in the scientific work. The patients were divided into two groups: 50 patients without a history of cardiac arrhythmia were selected in the first group (comparison group). The second group included 100 patients with cardiac arrhythmias of varying severity. The second group was divided into two subgroups: the 1st subgroup (2A) - patients examined before treatment and prescription of anticoagulants and antiarrhythmic drugs (50 people). The 2nd subgroup (2B) - patients after prescribing drugs and treatment (50 people). In each group, 50% of the subjects had carious lesions (caries of the initial and medium forms), and the other 50% had non-carious lesions (wedge-shaped defect and pathological erasability). In each group, on average, 30% of patients had periodontitis of moderate severity with supra- and subgingival dental deposits, with periodontal pockets of 4-5 mm, bleeding in 15% of cases in this group. Patients of the comparison group had their teeth cleaned according to the generally accepted scheme 1-2 times a day for 2-3 minutes. At the same time, all patients used the same toothpaste (such as Colgate total) and the same medium-hardness toothbrushes (such as President). Patients of the main group performed controlled brushing of teeth, the duration of which was determined individually for each patient by the method (LFD) [5,11-13], followed by the use of rinses (such as forest balm). In group 2B, the individual brushing time was selected to the indicators corresponding to their good condition, which varied from 2 to 8 minutes in different patients. At the same time, the hygienic condition was assessed according to the indicators of the difference in the intensity of fluorescence before and after hygienic treatment, and if the difference in indicators differs by no more than 0-20% believe that the measurement expressed by the pathological process is within the normal range, 21-49% satisfactory, 49-61% unsatisfactory, indicators 61% and above are considered bad and dangerous to human health. Hygienic treatment was carried out until the fluorescence indicators stopped changing and were stable for 10-20 seconds against the background of their hygienic treatment.

At the same time, in both groups, the degree of mineralization of hard tooth tissues was determined before and after their hygienic treatment by the RD method [11-13]. In addition, in the main group, after hygienic dental treatment, remineralizing therapy was performed based on the use of an application (remineralizing the drug with hydroxyapatite). This is due to the fact that in the process of hygienic treatment of hard tooth tissues (during the development of the technique), a decrease in their mineralization was revealed. The assessment of the dental status of the oral cavity was carried out by two methods: the generally accepted assessment method registered by "ad oculum": the Silnes index - Low, PHP, SBI index, CPITN, PBI bleeding index, Schiller-Pisarev test, PMA index [4,7,6], and by the method of Raman-fluorescence diagnostics (according to Alexandrov M.T) [5,11-13] such indicators as: digital integral index of oral hygiene, digitized Schiller-Pisarev test, oxygenation index, anaerobicity/anaerobicity index, digital index of microbial contamination of saliva, digital index of mineralization of hard tooth tissues by Raman microscopy. All patients were examined once a week for three months. Repeated examination, in full, was carried out once a month for six months. The results are presented in the form of graphs and tables after their statistical processing [14].

The scientific and clinical work was carried out in two stages (experimental and clinical):

The first stage is the clinical study of the method of LCD and Raman-fluorescent digital diagnostics for an objective assessment of the dental status of the oral cavity in patients with cardiac arrhythmia while taking anticoagulants. At the same time, indicators (expressed in percentages and relative units) were taken into account and recorded using the indicated digital method on the metabolic (digitized Schiller-Pisarev sample, oxygenation index, anaerobicity/anaerobicity index), morphometric (digital index of the hygienic condition of oral tissues, digital index of microbial contamination of saliva, digital index of mineralization of hard tooth tissues by Raman microscopy, the index of the degree of tissue infiltration), at the functional (these indicators are studied in dynamics) and clinical level (chronic periodontitis, caries, dental defects, swelling of the oral mucosa (cheeks, tongue, gums), redness of the oral mucosa, cyanosis of the lips and adjacent areas of the mucous membrane). It should be noted that the saliva index indicator used, estimated by the fluorescence intensity of the saliva microflora before brushing teeth in relative units, reflects integrally and collectively the hygienic state of all oral cavity biotopes, since saliva, as oral fluid, washes all oral cavity biotopes [17].

Subsequently, a comparative assessment of the hygienic state of the oral cavity (in the same patients) was conducted on the basis of subjective index indicators recorded by "ad oculum" and the

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methods of LFD and RF in combination and in interrelation, due to the fact that some of the methods of "ad oculum" (bleeding index, periodontal index) are currently not they can be replaced by LFD and RF methods.
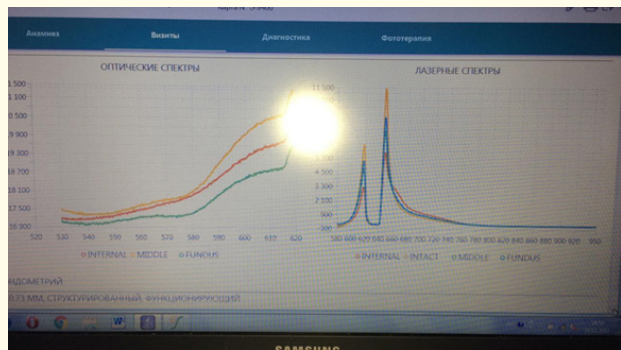
Equipment

The study was carried out on a device of the type "InSpectrM" in our modification.

**Figure 1:** The device of the type "InSpectrM".

The indicators of the screenshot of the computer display obtained during the examination of patients are shown in figure 2.

Figure 2: On the left, tissue oxygenation indicators in the form of normalized indicators in % (normalized index of oxidized and reduced hemoglobin).

The figure shows a screenshot from a computer display when assessing the mineralization of hard tooth tissues. Mineralization was determined by the spectral intensity of the Raman peak of hydroxyapatite on the fluorescence curve of the studied object.
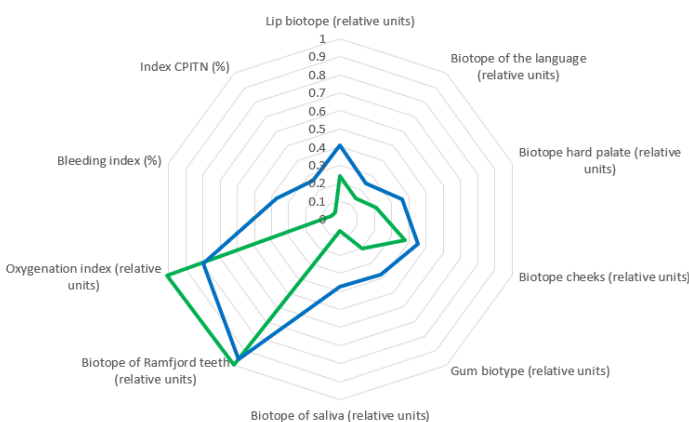
Thus, the presented materials and methods in their entirety correspond to the goals and objectives of the study.
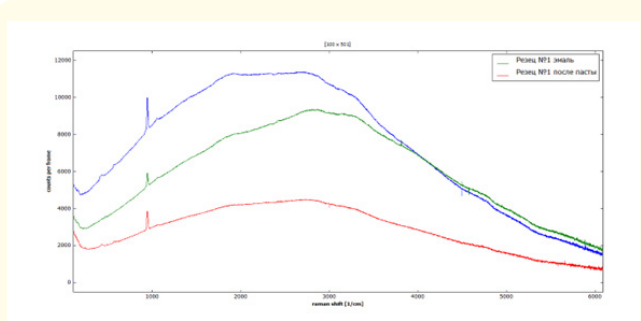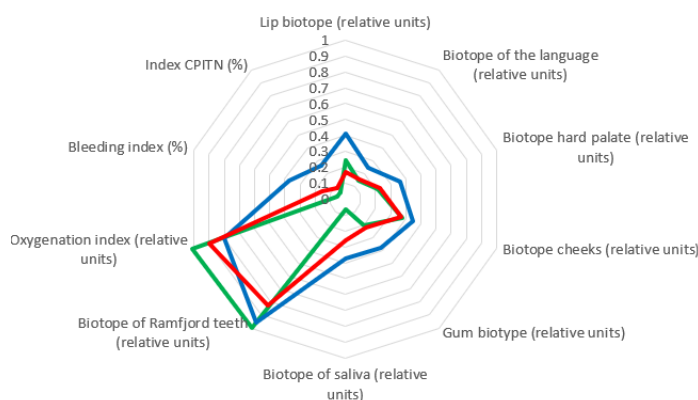

Figure 3: Screenshot of the computer display - simultaneous registration of fluorescence and Raman peaks at the stages of hygienic brushing of teeth (dynamics from top to bottom).

Research Results

A comparative analysis of the index methods of the studied "ad oculum" and digital methods of RFD was carried out at the morphometric, metabolic, functional and clinical level with the complex of the above-mentioned techniques. The results are presented in the form of graphs (Figure 4A, Figure 4B) and (Figure 5A, Figure 5B) - indicators of the hygienic condition of the oral cavity and mineralization of hard tissues of teeth before the study, against and after controlled hygienic treatment of the oral cavity and remineralizing therapy in patients with cardiac arrhythmia while taking anticoagulants, which cause a moderate decrease salivation, which possibly worsens the indicators of the hygienic condition of the oral cavity and negatively affects the mineralization of the hard tissues of the tooth.


Figure 4A: Indicators of oral cavity biotopes at the beginning of the examination.

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Figure 4B: Data obtained by measuring oral cavity biotopes after the examination of patients on the topic of scientific work, where green is the comparison group -1, blue is group 2A (before the examination), red 2B (after the examination after 6 months).
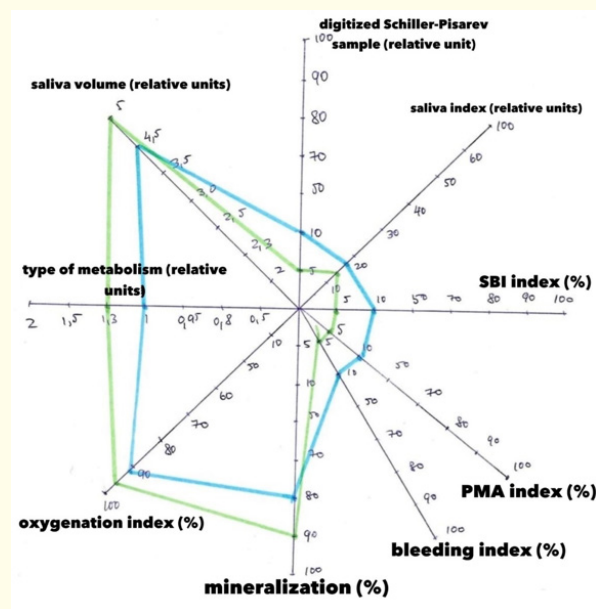
Figure 5B: Indicators of dental status 6 months after treatment, where green is an indicator of the norm; blue – patients examined after treatment according to the developed algorithm and prescribing anticoagulants and antiarrhythmic drugs.
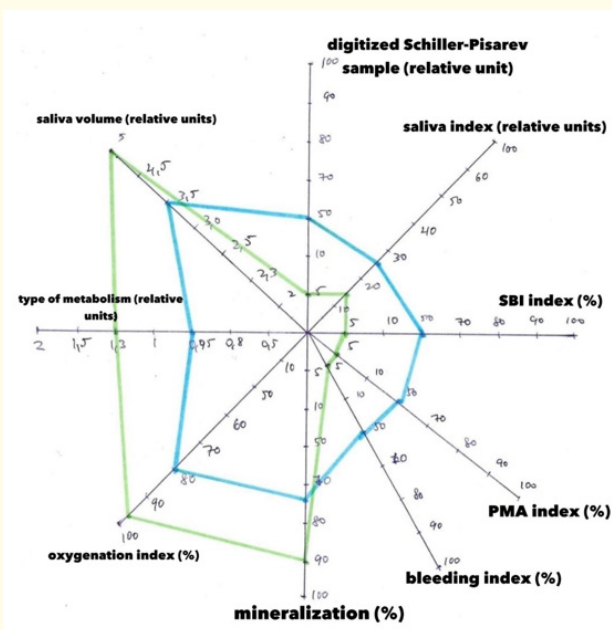
Figure 5A: Indicators of dental status before treatment, where green is an indicator of the norm; blue – patients examined before treatment and the appointment of anticoagulants and antiarrhythmic drugs.

The graph shows the data obtained by measuring oral cavity biotopes at the beginning of the examination of patients on the topic of scientific work, where green is the comparison group -1, blue is group 2 (the indicators of group 1 and group 2 are presented before their distribution into subgroups).

When using the Roman-fluorescence diagnostic method, indicators of dental status before the study presented in Figure 5A (initial data).

The integral assessment of the indicators recorded using the digital method of Raman-fluorescence diagnostics suggests that each of the above index indicators varies in different groups in different ways, but at the same time these changes occur simultaneously in all indicators, which ultimately allows the most objective assessment of the effectiveness of improving the dental status of the oral cavity. At the same time, we see changes in each of the index characteristics, which makes it possible to determine which therapeutic measures improve the health of the oral cavity. The dynamics of changes in these indicators are presented in table 1.

Thus, it is the cumulative assessment, in the relationship of all these indicators, which have a simultaneous manifestation in the oral cavity, that allows us to obtain objectively reliable data that determined an objective assessment of the effectiveness of treatment. At the same time, the assessment according to one of the indicators is one-sided and does not reflect the totality of factors affecting the homeostasis of the oral cavity in the nome and in pathology.

The results of the indicators of the examined patients at the clinical level are shown in the figures, where Figure 6A is the main group, Figure 6B is the indicators before the examination, Figure 6B is after the examination.

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Index indicators (N=150 patients) The norm is 50 Group 2.1S - 50 Group 2.2 - 50	Norm (Comparison Group)	Changes in indicators during treatment (before treatment) M average	The final change in indicators after treatment (after 6 months) M average
		Group 2A area under the curve	Group 2B area under the curve
Digitized Schiller-Pisarev sample (S cm2 of the pathological focus of metabolic disorders)	5 (relative units)	50 (relative units)	10 (relative units)
Saliva Index(assessment of the hygienic condition of the oral cavity)	12 (relative units)	25 (relative units)	15 (relative units)
Saliva volume	5 (ml/min)	3,1 (ml/min)	4,5 (ml/min)
Index SBI	5 (%)	50 (%)	10 (%)
Index PMA	5 (%)	50 (%)	10 (%)
Bleeding index	5 (%)	60 (%)	10 (%)
Oxygenation index	98 (%)	80(%)	91 (%)
Type of metabolism	1,3 (relative units)	0,9 (relative units)	1 (relative units)

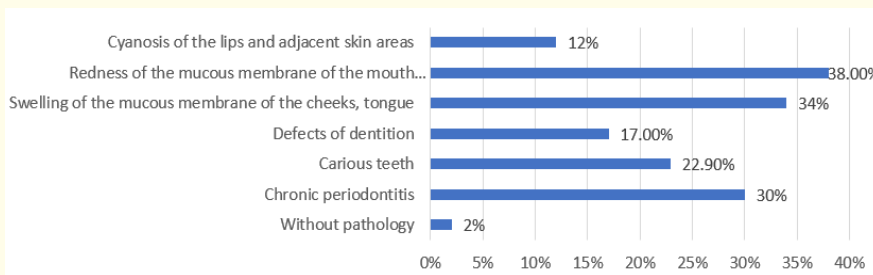**Table 1**: Changes in the indicators of the hygienic state of the oral cavity.

Figure 6A

Figure 6B

Figure 6C

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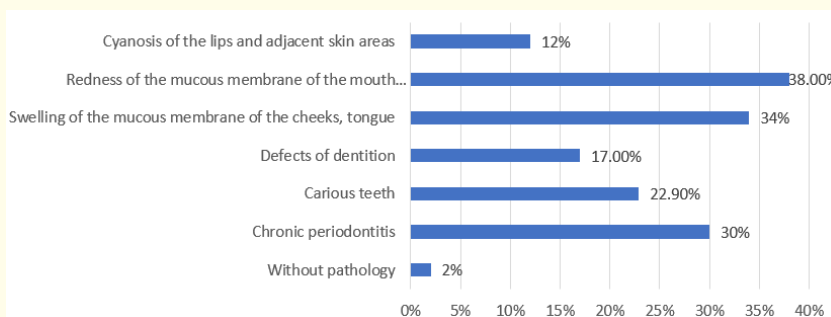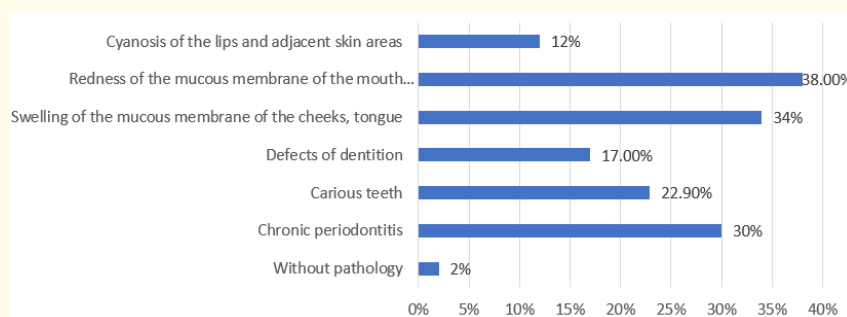
The medical technologies and techniques proposed by the ICE and the Russian Federation on their basis are objectively justified and recommended in 2006 by the Department of Preventive Medicine of the Russian Academy of Medical Sciences for introduction into clinical practice.

Conclusion

Based on the presented studies and literature data [4,2,6], it is shown that the error in measuring the dental status of the oral cavity in patients with cardiac arrhythmia while taking anticoagulants determined by "ad oculum" can range from 200% to 400%. That is, when comparing indicators, for example, the hygienic status of the oral cavity and the evaluation of the results of hygiene products, it is necessary to take into account the error of the method in the final indicators (not to be confused with the measurement error) which is not used in most scientific research. To eliminate these disadvantages of the "ad oculum" technology, we proposed using Raman-fluorescent technologies, which are digital and do not depend on the subjective "ad oculum" assessment of the dental status of the oral cavity. This has been repeatedly shown in studies [5,11-13,18]. That is why the use in our study to assess the homeostatic indicators of the oral cavity and/or its dental status, when exposed to certain means of hygienic treatment of the oral cavity, it was shown that the multifactorial assessment of various indicators in online mode is an objective, digital technique that allows to simultaneously and in conjunction to evaluate the totality of indicators that determine the homeostasis of the cavity mouth and its hygienic condition, including the determination of such indicators as: digitized Schiller-Pisarev sample, saliva index, SBI index, the PMA index, the bleeding index, the mineralization index, the oxygenation index, the type of metabolism, the volume of saliva, which are digital and reflect the dental status at the metabolic, morphometric, functional level. These indicators are directly dependent both on individual biotopes of the oral cavity and on the clinical data presented in the work, which have the same sanogenetic orientation (correlate with each other) when using controlled hygiene products and appropriate mineralizing therapy. The data obtained correspond to the latest studies presented in the scientific literature [11-13]. It should be noted that not all RFD indicators fully reflect the dental status of the oral cavity, since such indicators as: bleeding, periodontal index, have their own specifics and are not detected by the RFD method. Therefore, we have included them in the presented comprehensive methodology, which, from our point of view, allows us to characterize the dental status both in normal and in pathology. It should be emphasized that the presented methodology and its technical solution are based on a specialized software product that allows you to get a diagram of a comprehensive examination in almost real time and allows the doctor to evaluate both the norm indicator and various kinds of sanogenetic measures in the treatment of certain dental pathologies on the basis of objective data. The proposed methodology is proposed for implementation in clinical practice. Separately, it should be noted that in our age of digital medicine, the presented technology can be implemented in an affordable price category, which is the limit of our further developments.

During the approbation of the method, it was clinically shown that the use of the methodology developed by us, including the use of Raman-fluorescent technology and separate methods of registration of "ad oculum" showed that they objectively, simultaneously and in interrelation show the results of the effects of various exogenous and endogenous factors affecting the homeostasis of the oral cavity, and in particular when assessing its hygienic status, they show objective, positive, sanogenetic dynamics of S (area) under the curve of all index characteristics for the indicators of the main group as before the survey, after 6 months, it practically did not change and amounted to 45 cm^2. S (area) under the curve of index estimates for group 2A- (patients examined before treatment and prescription of anticoagulants and antiarrhythmic drugs) was 40 cm2, after treatment it was 38 cm^2.

- A Raman-fluorescent technology is proposed, which eliminates the presence of detected errors in the measurement of "ad oculum" and allows obtaining the results of assessing the dental status of the oral cavity and, in particular, its hygienic condition online, comprehensively and objectively and in the interrelation of all its elements, which is confirmed by the clinical results of scientific research.
- It is proved that for a comprehensive assessment of the hygienic status of the oral cavity, it is necessary to use both methods of Raman-fluorescent diagnostics and separate methods that complement each other and, currently, express methods of Raman-fluorescent diagnostics are not detected.
- The presented methodology and the algorithm of its clinical application most objectively assess the dental status of the oral cavity.

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