

Justification of the Use of Digital Methods to Assess the Hygienic Condition of the Oral Cavity

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DOI: 10.31080/ASDS.2023.07.1662**Received:** May 22, 2023**Published:** June 22, 2023© All rights are reserved by **Alexandrov M and Eganian DG****Abstract**

The scientific work substantiates the need for the use of index indicators of hygienic condition, such as visibility, lighting conditions of the doctor's workplace and indicators of grayness, in assessing the dental status of the oral cavity based on the "ad oculum" assessment. 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; Novel-Fluorescent Diagnostics; Hygiene Indices; Integral Indicator of the Hygienic State of the Oral Cavity

Introduction

The problem of objective assessment of the dental status of the oral cavity and the 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.

In addition, there are other little-studied errors of the methods registered by "ad oculum", due to the fact that when assessing the homeostasis of the oral cavity, such indicators as visibility, the influence of local and general lighting conditions of the dentist's workplace are not taken into account, gray indicators are not taken into account.

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 study the negative influence of factors of visibility, grayness and lighting conditions of the dentist's workplace on the indicators of homeostasis of the oral cavity and to justify the use of an objective digital method of Raman-fluorescent diagnostics to assess the dental status of the oral cavity, excluding the subjectivity of its indicators recorded by "ad oculum".

Tasks

- To assess the negative impact of visibility, grayness indicators and lighting conditions of the doctor's workplace (morning, afternoon, evening) on the indicators of the hygienic status of the patient's oral cavity.
- To carry out a comparative assessment of the existing index methods of "ad oculum" and methods of Raman-fluorescent diagnostics in characterizing the effectiveness, objectivity and accuracy of the assessment of the hygienic condition of the oral cavity.
- To substantiate the need for the integrated application of separate methods of "ad oculum" and methods of Raman-fluorescent diagnostics to improve the objectivity and effectiveness of the assessment of the dental status of the cavity.
- To conduct clinical testing of the proposed complex medical technology and evaluate its objectivity and effectiveness.

Materials and Methods

In total, 90 people were examined in the scientific work. All patients were divided into two groups: the comparison group – patients with controlled hygienic treatment of the oral cavity and without pronounced dental and somatic pathology and the main group - 2, where - 2A patients with uncontrolled hygienic treatment of the oral cavity, and concomitant unsatisfactory hygienic condition of the oral cavity and 2B patients with controlled hygienic treatment of the oral cavity and with a previous unsatisfactory hygienic condition of the oral cavity (which corresponds to the indicators before the start of controlled hygienic treatment of the oral cavity). There were 30 people in each group. The examined patients were aged from 25 to 50 years, without pronounced general somatic pathology. In each group of subjects 1,2A and 2B, carious lesions were detected (caries of initial and medium form-up to 50%). In addition, in each group, on average, 30% of patients had periodontitis of moderate severity with supra- and subgingival dental deposits, with periodontal pockets up to 4-5 mm, bleeding in 15% of cases. Patients of group 1 and group 2A were brushing their teeth 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 2b 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 indica-

tors 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 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 to substantiate the significance of the study of visibility, grayness, and the doctor's workplace for an objective assessment of the hygienic condition of the oral cavity. The assessment of the perception and influence of these indicators of visibility, grayness and lighting conditions on the "ad oculum" of the recorded results of the study was determined by 10 expert doctors.

At the same time, by visibility we mean a change in light and color perception, during the examination of the object, depending on the time of day, the illumination of the object and the conditions of the workplace, by the grayness scale we mean the ability of the sensitivity of the eye to perceive shades of gray, placed in the form of a table of standards, and its effect on the final color perception of the object [15,16]. The indicators were recorded in the daytime at 12:00, 18:00 and in the evening at 23:00.

The second 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. 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 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).

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

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 Ra Man 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.

Results of the Study

The first stage

After analyzing the obtained indicators, it was revealed that color perception, according to the laws of visibility, varies depending on the illumination of the object. This is shown in Figures 4A, 4B, 4C, 5.

As a result, it was revealed that the lighting area at 12:00 was 40-50 cm², at 18:00 - 80 cm², and at 23:00 - 110-120 cm². That is, the error in estimating the area of color perception under standard illumination by the same light source, depending on the time of day, was more than 200%.

Figure 4A: Indicators of illumination by laser radiation (Laser Stage Lighting Class IIIA) in the daytime (12:00) with natural light illumination and switched on lighting devices of local and general lighting with constant preservation of laser illumination.

Figure 4B: Indicators of illumination by laser radiation (Laser Stage Lighting Class IIIA) in the daytime (18:00) without natural light (the window is closed with a curtain), switched on by local and general lighting devices with constant preservation of laser illumination.

Figure 4C: Indicators of illumination by laser radiation (Laser Stage Lighting Class IIIA) in the evening (23:00) in complete darkness.

Another mistake that we have justified is related to the grayness scale, that is, the sensitivity of the eye to perceive shades of gray, placed in the form of a table of white standards. It was revealed that two experts saw color changes on the grayness scale by 40% of its indicators. Three of them saw a 55-60% grayness scale (further shades of gray were the same for them). Two more experts saw up to 65-70%, the remaining two up to 80%. That is, when assessing the sensitivity of the eye shades of gray in 10 doctors, the perception range has an error of up to 200% (the differences were 2 times). Thus, assessing the capabilities of a doctor when using the assessment of various indicators of dental status in the form of various generally accepted indices for the color of the object of study, it is necessary to take into account that the integral error of the change can be up to 400%, and this was only revealed by 10 experts.

The second stage

The presented provisions forced us to turn to digital technologies for assessing dental status, which did not depend on the subjectivity of the above indicators, and the totality of which could be registered online. As such, we used RFD diagnostic methods. 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 6A, 6B) and (Figure 7A-C) - indicators of the hygienic condition of the oral cavity and mineralization of hard tissues of the teeth before the start of the study, against and after controlled hygienic treatment of the oral cavity and remineralizing therapy.

Figure 5: The difference in light perception indicators depending on the lighting and time of day (on the left - 12:00 o'clock, on the right - 23:00).

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).

Figure 6A: Indicators of oral cavity biotopes at the beginning of the examination.

Figure 6B: 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).

When using the Raman-fluorescent diagnostic method, the indicators of dental status before the start of the study are shown in figure 7A (initial data).

Figure 7A: Indicators (diagram) of the hygienic condition of the oral cavity before the examination. Green - group 1, red - main group 2A, blue -main group 2B.

Clinical indicators also had a positive sanogenetic orientation, as well as data obtained on the basis of express digital Raman-fluorescent methods of examination of patients (Figure 8A-C).

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.

Figure 7B: Indicators of the hygienic state of the oral cavity after 3 months. Green - group 1, red - main group 2A, blue - main group 2B.

Figure 7C: Indicators of the hygienic state of the oral cavity after 6 months and remineralizing therapy. Green is group 1, red is the main group 2A, blue is the main group 2B. There is a significant improvement in the indicators in group 2B compared to patients in group 2A, with almost unchanged indicators of the comparison group-1.

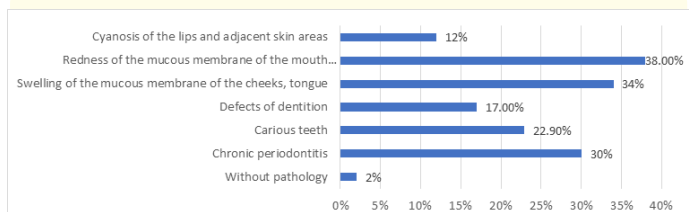


Figure 8A

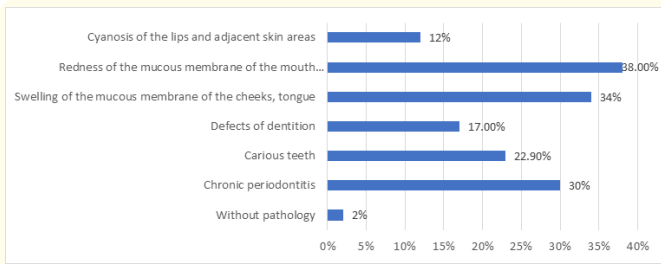


Figure 8B

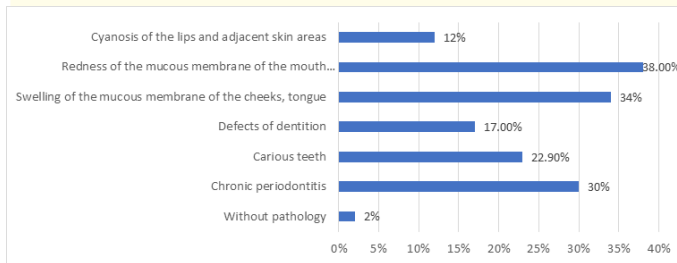


Figure 8C

Discussion of the Results of the Study

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 “ad oculum” can range from 200% to 400%. That is, when comparing indicators, for example, the hygienic condition of the oral cavity and evaluating the results of the use 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 combination-fluorescent technologies, which are inherently independent of the color, grayness and lighting conditions of the object, are digital and objective. This has been repeatedly shown in studies [5,11-13,18,19]. That is why, when used in our study to assess the homeostatic indicators of the oral cavity and/or its dental status, when exposed to certain means of oral hygiene treatment, it was shown that a multifactorial assessment of various indicators in online mode is an objective, digital technique that allows simultaneously and collectively assess the totality of indicators that determine the homeostasis of the oral cavity and its hygienic condition, including the determination of such indicators as: digitized Schiller-Pisarev sample, saliva index, SBI index, PMA index, bleeding index, mineralization index, oxygenation index, type of metabolism, saliva volume, which are digital and reflect the condition of teeth at the metabolic, morphometric, functional level. These indicators directly depend both on the 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 indica-

tors 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 comprehensive examination scheme 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 based on 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 the S area of graphs under the curve for all index characteristics of the indicators of the main group as before treatment, and after the treatment, it practically did not change and amounted to 45 cm² (the totality of indicators during the examination was 135cm²). S (area) under the curve of index estimates for group 2A was 38 cm² before the examination, 32 cm² after 3 months and 37 cm² after 6 months. The totality of indicators is 107 cm². For group 2B - 49 cm² before the examination, 38 cm² after 3 months and 41 cm² after 6 months. The totality of indicators is 128 cm²). The difference in the final indicators for groups 2A and 2B in relation to the main group was (2A = 21%, 2B = 5%), while, in the dynamics of the sanogenetic process, in percentage terms, oxygenation indicators (+10%), saliva index indicators (-12%), mineralization (+3%), index values of PMA (-45%) and SBI (-60%) normalized and improved with controlled brushing of teeth.

Conclusions

- When assessing the dental status and, in particular, its hygienic condition of the oral cavity, it is necessary to take into account such indicators as visibility, grayness and lighting conditions of the dentist’s workplace. At the same time, it is shown that the measurement error of the “ad oculum” method is from 200 to 400 percent.
- The Raman-fluorescent technology is proposed, which eliminates the presence of detected errors when measuring “ad oculum” and allows to obtain the results of assessing the dental status of the oral cavity and, in particular, its hygienic con-

dition online, comprehensively and objectively, 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 individual methods that are currently not detected by express methods of Raman-fluorescent diagnostics.

The presented methodology most objectively assesses the dental status of the oral cavity.

Bibliography

1. Karaseva VV., et al. "Assessment of dental status, monitoring of individual hygiene and quality of life of patients with jaw defects in combination with medical osteonecrosis". *Dentistry = Stomatologiya* 99.5 (2020): 80-86.
2. Makeeva IM., et al. "Oral hygiene and dental health of first moscow state medical university students". *Rossiyskii stomatologicheskii zhurnal* 21 (6 (2017): 337-339.
3. Shirshova NE., et al. "Methodological aspects of assessing the state of oral hygiene in young people". *Perm Medical Journal* 6 (2006): 107-112.
4. Admakin OI., et al. "Assessment of the level of oral hygiene and the condition of periodontal tissues in interns and residents of the Department of Therapeutic Dentistry of the First Moscow State Medical University im. Sechenov". *Sechenovsky Bulletin* 3.21 (2015): 27-30.
5. Aleksandrov MT., et al. "Integrated assessment of hygienic condition of the oral cavity". *Stomatologiya* 99.4 (2020): 21-26.
6. Alexandrov MT., et al. "The use of laser fluorescence to assess the hygienic state of the oral cavity". *Vestnik RAMN* (2003): 39-44.
7. Babina KS., et al. "Choice of method for index assessment of the hygienic state of the oral cavity". *Sechenovskiy Vestnik* 1.11 (2013): 10-14.
8. Kuzmina EM. "Prevention of dental diseases". M. «Tongaprint» (2003): 216.
9. Utyuzh AS., et al. "Clinical significance of spectral studies of the hygienic state of the oral cavity in patients with removable and non-removable prosthetic structures". dissertation (2021): 145.
10. Index of oral hygiene.
11. Mulleman's bleeding index (modified by Cowell) [Electronic resource].
12. Aleksandrov MT., et al. "The use of laser-conversion diagnostics in dentistry (review), Sat". tr. Scientific-practical conference of the Student Scientific Society of the Faculty of Dentistry, dedicated to the memory of Academician of the Russian Academy of Medical Sciences, Professor Bazhanov N.N. - M.: MG MU named after I.M. Sechenov (2011): 4-5.
13. Alexandrov MT. "Laser clinical biophotometry (theory, experiment, practice), Technosphere (2008): 584.
14. Gunko VI., et al. "Improving the efficiency of diagnosis and treatment of patients with purulent-inflammatory diseases based on the use of laser fluorescence diagnostics". *Vestnik RUDN University. Series: Medicine* 1 (2012): 93-96.
15. Urbakh VYu. "Biometric methods. Statistical processing of experimental data in biology, agriculture and medicine., "Mathematical statistics for biologists and physicians" (Publishing house of the Academy of Sciences of the USSR, 1963) - 246-255.
16. Nature of color and colors of nature [Electronic resource].
17. Tezikov DA. "Optimization of hygienic care for removable orthopedic structures based on the study of the effect of ultraviolet radiation on the microflora of removable dentures, Perm (2014): 26.
18. Alexandrov MT. "Laser Raman-fluorescent medical technologies in dentistry from experiment to clinic, Ed. Alexandrova M.T. - Moscow: Knigizdat (2020): 160.
19. Alexandrov MT., et al. "Dentistry (XX century). Textbook for high schools". Publishing house house GOETAR-MED (2008): 415.