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Research Article

Conceptual Justification of the Use of Raman-Fluorescent Medical Technologies for a Comprehensive Assessment of the Hygienic Condition of the Oral Cavity

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Abstract

The scientific article conceptually substantiates an innovative method of objective assessment of the dental status of the oral cavity based on index indicators of its hygienic condition, eliminating the negative impact of indicators such as visibility, lighting conditions of the doctor's workplace and indicators of gray color. It is objectively justified that, without taking into account these indicators, the error in the method of assessing the hygienic condition of various biotopes of the oral cavity "ad oculum" ranges from 200 to 600 percent. In this regard, objective Raman-fluorescent medical technologies are proposed that eliminate the specified measurement error of "ad oculum", which are conceptually and clinically confirmed in the dental clinic. Integral assessment.

Keywords: Conceptual Justification; Raman-Fluorescent; Hygienic; Oral Cavity

Introduction

The problem of an objective comprehensive rapid assessment of the dental status of the oral cavity is still debatable [9,15,16]. This is evidenced by the lack of unity and the wide variety of visually evaluated indexes used for the above purposes. [9,15,16] In this case, the error of the method (not of a single measurement, but of the method as a whole) may be more than 200%. [1,2,18]. In the literature available to us, these subjectively defined indexes usually include: The PHP Oral Hygiene Efficiency Index, the PMA Index, the Silness loe index, the Mulemann-Cowell index, the OHI-S, the Green-Wermillion index, the Ulitovsky-Leontiev index [1,4,8,10,11].In our opinion, the presented indicators do not take into account such poorly understood errors of the methods registered by ad oculum as visibility, the influence of local and general lighting conditions of the dentist's workplace, and gray indicators.

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 the dental status of the oral cavity and the development of medical digital technology for its rapid and integral assessment.

As a working medical technology to solve this urgent problem, it is proposed to use the digital method of Raman-fluorescence diagnostics (RFD), which does not have the above errors [2,3,19,20].

Objective

To study the negative impact of factors of visibility, grayness and lighting conditions of the dentist's workplace on the indicators of the dental status of the oral cavity and to justify the use of an objective digital express method of Raman-fluorescence diagnostics for its comprehensive assessment, excluding the subjectivity of the 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 substantiate the need for the integrated use of individual ad oculum methods and Raman-fluorescence diagnostic methods to increase the objectivity and effectiveness of rapid assessment of the dental status of the cavity, including assessment of the mineralization of hard tooth tissues.

- To conduct a clinical approbation of the proposed comprehensive medical technology and evaluate its objectivity and effectiveness.

Materials and Methods

A total of 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 pre-existing unsatisfactory hygienic condition of the oral cavity (which corresponds to the indicators before the start of the controlled hygienic treatment of the oral cavity). There were 30 people in each group. The examined patients ranged in age from 25 to 50 years, without pronounced general somatic pathology. Carious lesions were detected in each group of subjects 1,2A and 2B (initial and moderate caries -up to 50%). In addition, in each group, on average, 30% of patients had moderate periodontitis with supra- and subgingival dental deposits, with periodontal pockets up to 4-5 mm, and bleeding in 15% of cases. Patients of group 1 and group 2A had their teeth cleaned according to the standard scheme 1-2 times a day for 2-3 minutes. At the same time, all patients used the same toothpaste (Colgate total type) and the same toothbrushes of medium hardness (President type). Patients in the main group 2b underwent controlled tooth brushing, the duration of which was determined individually for each patient by the method (LFD) [2,3,19,20,22], followed by the use of mouthwashes (such as forest balm). In group 2B, the individual brushing time was adjusted to the values corresponding to their good condition, which varied from 2 to 8 minutes in different patients (Fig.2,6A). At the same time, the hygienic condition was assessed by the difference in fluorescence intensity before and after hygienic treatment, and if the difference in indicators differs by no more than 0-20% consider that the measurement expressed by the pathological process is within the normal range - good hygienic condition of the oral cavity, 21-49% - satisfactory condition, 49-61%- unsatisfactory condition, 61% and The above was assessed as a poor hygienic condition of the oral cavity. Hygienic treatment was carried out until the fluorescence indicators stopped changing and were stable for 10-20 seconds of hygienic treatment of the oral cavity.

At the same time, in both groups, the degree of mineralization of the hard tissues of the tooth was determined (Fig. 3-according to Alexandrov M.T.) before and after their hygienic treatment by the RD method [3,19,20]. In addition, in the main group-2B, after hygienic dental treatment, remineralizing therapy was performed based on the use of an application (remineralizing preparation with hydroxyappatite-applications of a moistened preparation for 3 minutes). This is due to the fact that during the hygienic treatment of hard tooth tissues (during the development of the technique), a decrease in their mineralization was detected. The dental status of the oral cavity was assessed using two methods: the generally accepted assessment method registered by ad oculum: the Silnes-Low index, PHP, the SBI index, CPITN, the PBI bleeding index, the Schiller-Pisarev test, the PMA index [1,4,18], and the method of Raman-fluorescence diagnostics (according to M.T. Alexandrov, - 2,3,19,20) 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 (according to Alexandrov M.T-see 5,8). Repeated examination, in full They were carried out once a month for six months. The results are presented in the form of graphs and tables after their statistical processing by (Biometrics, V.Y. Urbakht 1963).

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

The first stage was to substantiate the importance of studying the visibility, grayness, and illumination of the doctor's workplace for an objective assessment of the hygienic condition of the oral cavity.

At the same time, by visibility we mean how the eye perceives radiation of various spectral composition (optical range) at different times of the day (color perception) [21]. That is, the light and color perception of an object during its examination, depending on the time of day, the illumination of the object and the workplace.

The grayness scale is usually considered to be the ability of vision to perceive and transform light radiation of a certain spectral composition into a sensation of various shades and tones, which is assessed by the ability of the eye to perceive shades of gray, which is assessed by the grayness scale table [22]. The indicators were recorded during the daytime at 12:00, 18:00 and evening at 23:00.

The second stage is the clinical development of a digital method of Raman-fluorescence 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 test, oxygenation index, anaerobicity/anaerobility index), morphometric (digital index of 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 levels (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).

Equipment

The study was carried out on an InSpectrum-type device in our modification (Figure 1).

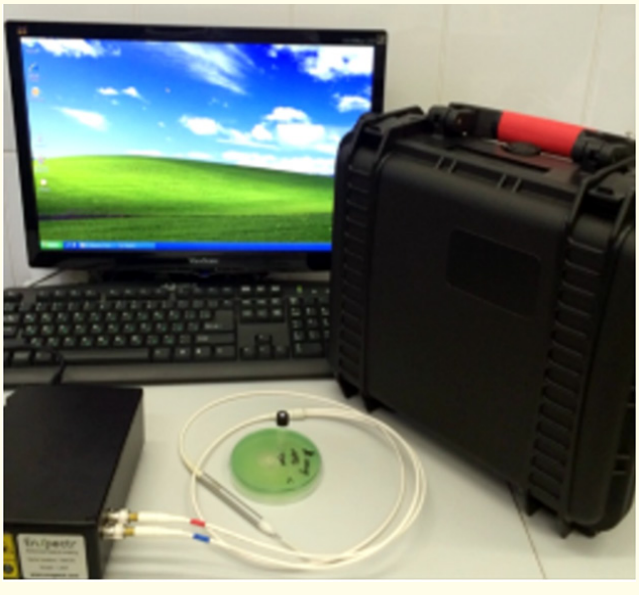


Figure 1: InSpectrum-type device.

The indicators of the screenshot of the computer display obtained during the examination of patients are presented in figure 2,3.

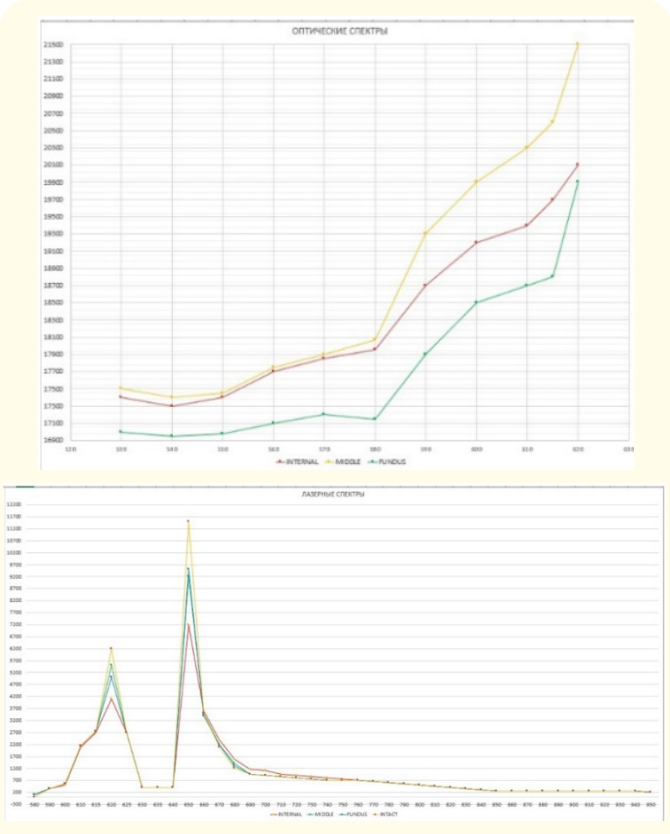
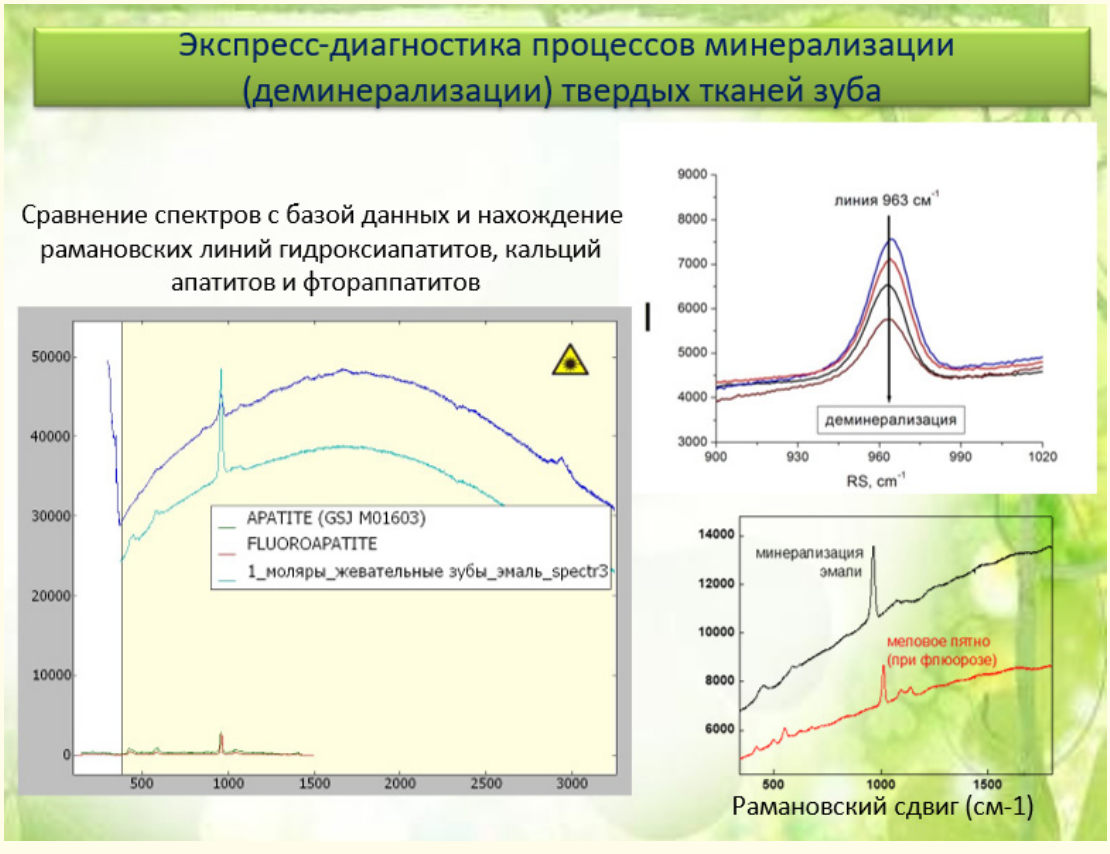


Figure 2: On the left, tissue oxygenation indicators in the form of normalized indicators in % (normalized index for oxidized and reduced hemoglobin), on the right are fluorescence indicators (the first peak-reflected signal of probing laser radiation and its intensity in relative units; 2 spctr - indicators of fluorescence of the object under study and its intensity in relative units).



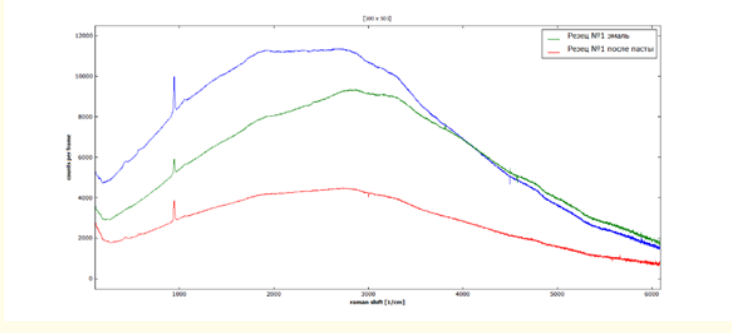


Figure 3: Raman fluorescence diagnostics - simultaneous registration of fluorescence and Raman peaks at the stages of hygienic teeth cleaning (dynamics from top to bottom). Mineralization was determined by the spectral intensity of the Raman peak of hydroxyapatite on the fluorescence curve of the object under study (in % relation to the initial spectral intensity of hydroxylappatite-upper graph).

The results were processed using the methods of variational swastika according to the methods of V.Y. Urbakht, 1963 [7].

Thus, the presented materials and methods in their entirety correspond to the goals and objectives of the study.

Results of the study

It was revealed that color perception according to the laws of visibility changes depending on the illumination of the object. This is shown in the figure 4 (A-C). (Figure 5).

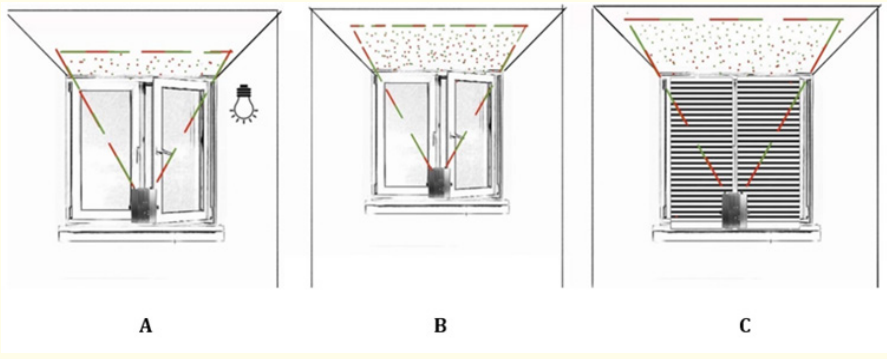


Figure 4

A: Laser Stage Lighting Class IIIA indicators of illumination in the daytime (12:00) with natural light and local and general lighting devices turned on, while the laser illumination is always preserved.

B: Laser Stage Lighting Class IIIA indicators of illumination in the daytime (18:00) without natural light (the window is covered with a curtain), turned on local and general lighting devices with the laser illumination constantly preserved.

C: Laser Stage Lighting Class IIIA in the evening (23:00) in complete darkness.

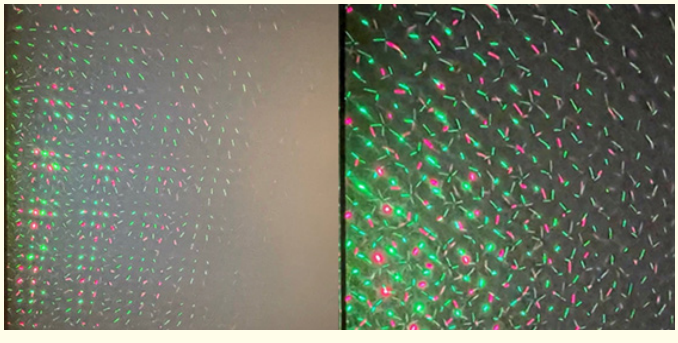


Figure 5: Difference in light perception depending on lighting and time of day (left - 12:00 hours, right - 23:00).

Then it was revealed that the lighting area at 12:00 was 42-55 cm2, at 18:00 - 81-88 cm2, and at 23:00 - 110-120 cm2. That is, the error in estimating the area of color perception in standard lighting, depending on the time of day, was more than 200%.

Another error was related to the perception of the shades of gray scale, that is, the sensitivity of the eye to perceive shades of gray was assessed according to the table of standards (dic/academic.ru). It was revealed that two experts (dentists) saw color changes on the gray scale by 40-45% of its indicators. Three of them saw 58-63% of the gray scale (then the shades of gray were the same for them). Four more experts saw a change in shades of gray to 70-81%. That is, when assessing the sensitivity of the eye to shades of gray, 10 doctors have a range of perception with an error of up to 200% (the differences were 2 times). Thus, evaluating the capabilities of a doctor when using estimates of various indicators of dental status in the form of various generally accepted, visually evaluated indices can integrally amount to 400%, and taking into account the above error (excluding the indicators we studied -see: 1,2,18) - up to 600%, since the error of any method is equal to the sum of all measurement errors.

The second stage. Next, we conducted an equal analysis of the index methods of the studied “ad oculum” and digital methods of RFD, which included indicators recorded at the metabolic, morphometric, functional and clinical levels in their interrelation. The re-

sults are presented in the form of graphs (Figure 6A,B) 0 indicators of biotopes of the oral cavity before and after hygienic treatment of the oral cavity and (Figure 7A-C) - indicators of the hygienic condition of the oral cavity and mineralization of hard tissues of teeth before and after controlled hygienic treatment of the oral cavity and remineralizing therapy.

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

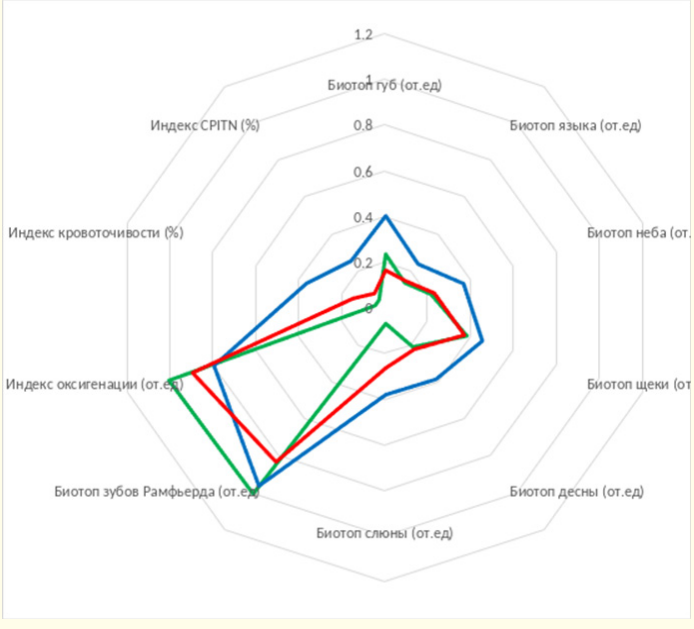


Figure 6: A) Average data obtained when measuring oral cavity biotopes before and after its hygienic treatment, where green is the norm, blue - before, red - after hygienic treatment of the oral cavity (with the standard time of hygienic treatment of oral cavity teeth - 3 minutes, brush of medium hardness).

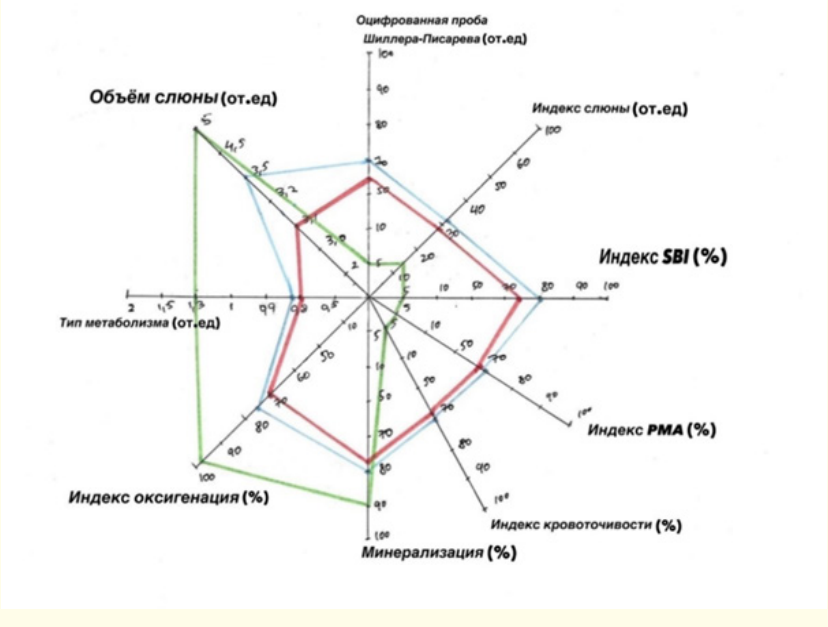


Figure 7: A Average indicators (diagram) of the hygienic state of the oral cavity before the examination. Green - group 1, red - main group 2A, blue - main group 2B.

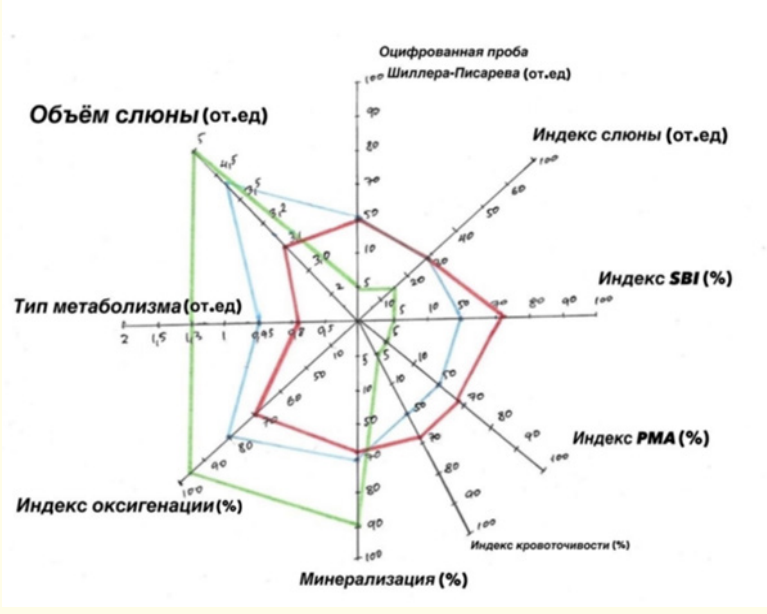


Figure 7: B) Average indicators of oral hygiene after 3 months. Green - group 1, red - main group 2A, blue - main group 2B.

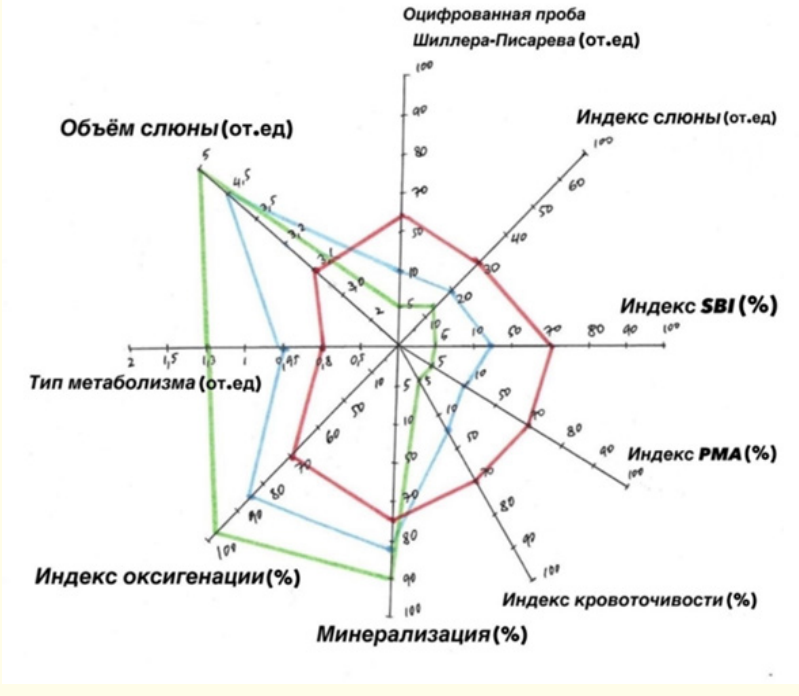


Figure 7: C) Mean indicators of oral hygiene after 6 months and remineralization therapy. Green - group 1, red - main group 2A, blue - main group 2B. There is a significant increase in indicators in group 2B compared to patients of group 2A, with practically unchanged indicators of the comparison group-1.

Figure 8: A, B, C-from top to bottom) Characteristics of patients' indicators at the clinical level, where A is group 1, B is group 2B before the examination, C is group 2B, after the examination.

Discussion of the Results of the Study

Based on the presented studies and literature data [1,15,18], it is shown that the error in measuring the patient's hygienic status, determined by "ad oculum", can range from 200% to 600%. That is, when comparing indicators, for example, the hygienic status of the oral cavity and the evaluation of the results of hygiene products using the "ad oculum" method without taking into account the presented results, the revealed error of the method does not allow us to consider the data of most scientific studies and clinical observations objectively justified (false-positive result).In the literature available to us, we have not identified studies where the result before and after oral hygiene treatment would exceed the indicated measurement error (that is, it was apparently falsely positive. Thus, the dental technologies of "ad oculum" must be replaced by more objective digital methods that do not have these disadvantages. In this regard, to eliminate these disadvantages of the "ad oculum" technology, we proposed using Raman-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 [2,3,5,19,20]. That is why the use in our study to assess the dental status of the oral cavity, when exposed to certain means of hygienic treatment, was justified, pathologically and sanogenetically, by its multifactorial RFD assessment, which allows simultaneous and interrelated assessment of the entire set of indicators such as: digitized Schiller-Pisarev test, saliva index, SBI index, PMA, bleeding index, mineralization index, oxygenation index, type of metabolism, saliva volume, which are digital and objectively characterize the patient's dental status on a metabolic, morphometric, and functional level. These indicators are directly dependent on the clinical data presented in the work and have the same sanogenetic orientation. The data obtained correspond to the latest research presented in the scientific literature [3,19,20].

It should be emphasized that the presented methodology and its technical solution are based on a specialized software product. It should be noted separately that in our age of digital medicine, the presented technology can be implemented in an affordable price range, which is the limit of our further developments.

Conclusions

- When assessing the dental status and, in particular, the 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 ranges from 200 to 600 percent.
- The proposed Raman-fluorescent technology eliminates the presence of identified errors in the measurement of "ad oculum" and allows you to obtain objective results of assessing the dental status of the oral cavity online, comprehensively 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 Raman-fluorescence diagnostic methods and individual "ad oculum" methods, which are currently not detected by express methods of Raman-fluorescence diagnostics.
- The presented methodology and algorithm of its clinical application are recommended for implementation in the practice of a dentist.

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