USING OF OPTOELECTRONIC METHODS FOR ANALYSIS OF MICROCIRCULATORY DISORDERS IN INFLAMMATORY PROCESSES IN THE MAXILLOFACIAL REGION

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Introduction. In the pathogenesis of odontogenic inflammatory diseases, an important role plays disruption of blood circulation in the tissues of the maxillofacial region, as consider many authors (V.M.Uvarov, M.M.Solovyev, T.M.Alehova). These statements are based on the topographic anatomical, morphological studies, and on data of studying the blood coagulation. However, all of these methods allow only indirectly define the state of the regional blood flow. Therefore, use of such actual methods as rheoplethismography and photoplethismography is very perspective. These methods allow to study the pathogenesis of periodontal disease, periodontitis, mumps and other pathological processes in the maxillofacial region.

Materials and methods. In recent years, in the practice of functional diagnostics are introduced photoplethismographic methods for registration of biosignals. These methods based on irradiation the area of the tissue of the biological object by infrared beam and recording the radiation, transmitted through the tissue or reflected from it, by optoelectronic sensor. The use of optoelectronic sensors has provided new opportunities for the diagnosis of the state of the cardiovascular system.

The main advantage of this method - it is the possibility of measuring the microcirculation level almost anywhere in the body surface, that allows to use the different modifications of optical devices to solving a number of specific tasks related to the study of indicators of local blood flow (diagnosis of microcirculation in spinal motion segments, assessing the state of the microcirculation of the lower legs in the disease of the systemic lupus erythematosus, vascular state assessment in the maxillofacial region in inflammatory processes, analysis of hemodynamic blood flow in pulse diagnosis, and etc.). Furthermore, depending on the particular method of measurement may be estimated such parameters as the biomedical total concentration of hemoglobin, total blood oxygen saturation (the degree of oxygen saturation), total bilirubin concentration. Photoplethismographic (PPG) curve shows the phase changes of blood filling of the peripheral vascular in inflammatory processes respectively cardiac cycle.

To improve the reliability of received PPG information an optoelectronic complex was developed, using *a priori* information, including the physical characteristics of the measurement object, the mathematical relation between the measured values, the data about the spectral composition of informative components and noise, also basic biophysical characteristics of the controlled object. The engineered optoelectronic complex allows to diagnose the state of blood vessels by express method at different stages of the disease and to fix the degree of microcirculation and hemodynamic disturbances in some areas by comparing the received signals.

Фотобиология и экспериментальная фотомедицина

This device – is a converter for displaying and comparing the transformed biomedical signals. It is possible to connect the device to PC via a coupling unit. This significantly expands such functionality of the device as recording of biomedical signals to the archive, their preprocessing (scaling, filtering), comparison and correlation analysis and building the charts and graphs on the PC.

Results. 30 patients (21 men and 9 women aged 20 to 60 years) with odontogenic abscesses and phlegmon were examined at the Department of Maxillofacial Surgery of the Vinnitsa National Medical University. Treatment of patients included removal of the causative tooth, opening cellulitis or abscess, ozone therapy with silver ions.

PPG studies were carried out on the optoelectronic diagnostic complex for analysis of microcirculatory disorders. The optical radiation was directed to the biological tissue at a distance of 10 mm from the edge of the surgical wound or intended cut. As a control point was symmetric point of study. Photoplethismographic signals (PPGS) were registered in the inflammatory focus and in the control point before the operation, and on the third and fifth day after operation. There were recorded 180 PPGS, and the obtained data were processed by designed program «WOSTEO».

Discussing of the results. During the analysis of obtained data it was set that PPGS of phlegmon and abscess significantly differed of control.

Before surgery, the level of blood filling (PPG index) in the inflammatory focus is significantly increased in 2,5-3,5 times. State of venous outflow was sharply deteriorated. That was appeared in the change of form of decaying limb (it that has become more prominent – 73,3%). Dicrotic jag was less expressed and shifted to the top of the catacrotism (70%). In 22 cases is noted the appearance of additional venous waveform. The blood flow velocity is reduced due to the further deterioration of the venous outflow. In 76,6% of cases there were additional dicrotic waves, 30% were marked small additional jags on catacrotism.

At the 5-6 days after surgery blood flow was improved in all indicators. Additional waves were disappeared in 46,6%, and were weakened in 53,4%. However, in the case of PPGS of inflammatory focus the difference from control point was remained.

Conclusion. Using of the PPG method is allows to assess accurately the level of blood-filling in inflammatory processes, thus, this method has the such positive properties: noninvasive, high degree of sensitivity and reliability, ease of study. Application of this method allows dentists accurately determine: the effectiveness of the treatment; specify the duration of the rehabilitation period; identify various vascular disorders in fractures of the jaw; to evaluate the effectiveness of local anesthesia (anesthesia causes vasospasm, and reducing of the amplitude of the signal is the feature of the effectiveness of anesthesia); to apply this method to plastic surgery and transplantation.

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КОМБИНИРОВАННОЕ ВОЗДЕЙСТВИЕ ЛАЗЕРНОГО ИЗЛУЧЕНИЯ НА ЗУБНУЮ ТКАНЬ

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Выполнено экспериментальное исследование по обработке зубной ткани (эмали и зубного камня) излучением на длине волны 0,53 мкм, 1,06 мкм и по комбинированному воздействию (длина волны 1,06 мкм и 0,53 мкм).

Для исследования комбинированного воздействия был использован лазер «Лотис». В выходном излучении лазера «Лотис» (TII LS2147) присутствует первая и вторая гармоники излучения (длина волны 1,06 мкм и 0,53 мкм).

Для определения энергии импульса на длине волны 0,53 мкм и 1,06 мкм, а также для выделения излучения с определенной длиной волны была использована оптическая схема, представленная на рис. 1.

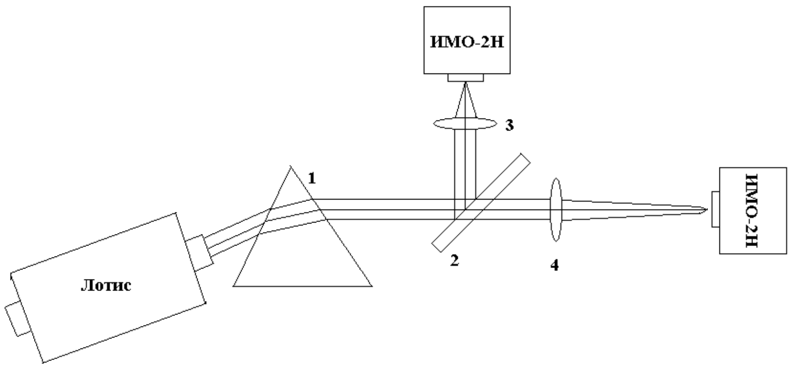

Рис. 1. Оптическая схема для определения энергии импульса на длине волны 0,53 мкм и 1,06 мкм

Изучение лазера «Лотис» направлялось на призму (1) и происходило пространственное разделение пучков с длинами волн 0,53 мкм и 1,06 мкм. При направлении на подложку (2) пучка с соответствующей длиной волны определялась энергия. Излучение, которое проходило через линзу (4) направлялось на исследуемый объект. Излучение, отраженное от подложки (2), проходило через линзу (3) и попадало измеритель энергии, который использовался для контроля. Производилась калибровка показаний ИМО-2Н для контроля величины энергии. Кроме того, определялось соотношение между энергиями на длинах волны 0,53 мкм и 1,06 мкм в зависимости от уровня накачки.

Образцы зубной ткани облучались при использовании частоты повторения импульсов 10 Гц серией из 1000 импульсов.

Исследована зависимость глубины кратера в зубной эмали и в зубном камне в зависимости от плотности энергии излучения и от плотности мощности на длине волны 1,06 мкм (после 1000 импульсов). Полученные результаты представлены на рис. 2.

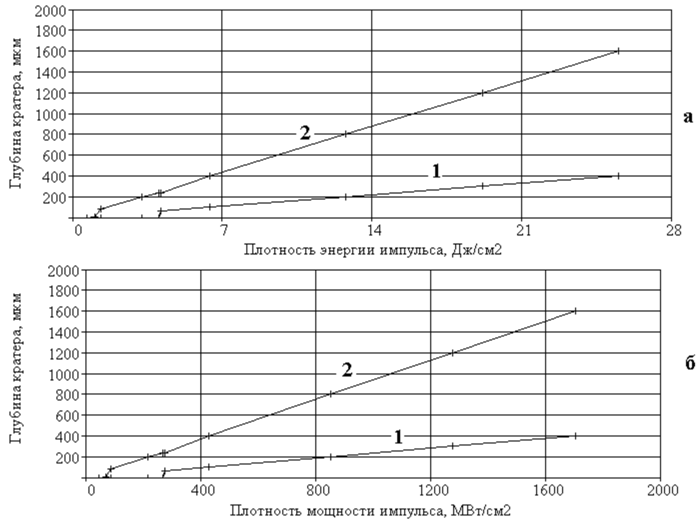

Рис. 2. Зависимость глубины кратера в зубной эмали (1) и зубном камне (2) от плотности энергии (а) и от плотности мощности (б)

Установлено, что порог абляции зубной эмали составляет 12 Дж, а порог абляции зубного камня составляет 3 Дж/см^2. Зубной камень может эффективно удаляться с поверхности эмали при плотности энергии ~3-12 Дж/см^2

Исследована зависимость глубины кратера в зубной эмали и в зубном камне в зависимости от плотности энергии излучения и от плотности и