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PHOTOPLETHYSMOGRAPHY METHOD FOR INVESTIGATION OF TISSUE MICROCIRCULATION DISORDERS AFTER TOOTH EXTRACTION USING IN PATIENTS WITH DIABETES

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Abstract

The use of photoplethysmographic method allows to accurately assess the level of blood supply in inflammatory manifestations in patients with diabetes after tooth extraction, this method has positive properties: non-invasive, high sensitivity and probability ease of study. It is shown that photon radiation increases the elasticity of blood vessel walls, elasticity of erythrocytes, oxygen transport function of blood, activity of cell membranes, acceleration of tissue regeneration, reduction of lipid oxidation, normalization of blood rheology.

Keywords: *photoplethysmographic method, propagation of laser radiation, optic-electronic system, photonic therapy, microcirculation.*

Introduction

In clinical dentistry, examination of the microcirculatory system of all tissues and organs of the oral cavity is of considerable interest as one of the methods of studying the blood supply to tissues [1,2,3].

Nowadays , the use of traditional methods of examination and diagnosis is insufficient: examination, percussion, electroodontodiagnostics, rheography, radiography, and others. New, more effective methods of differential diagnosis, using laser and optoelectronic computerized systems and complexes are being developed for in-depth study of the condition of tissues and organs of the maxillofacial area. Today, laser treatment and diagnostic technologies are used in dental institutions around the world [4,5,6].

Methodology. Model of interaction of laser radiation with biological tissues of different types

Many mathematical models are used to describe the interaction of laser radiation with biological tissues, and the theory of radiation transfer is most often used. The equation describing the propagation of laser radiation in biotissue, taking into account the absorption and scattering has the form

$$\frac{dL_c(r,z)}{dz} = -gL_c(r,z)$$

where *Lc(r,z)* radiation power density [W/m^2] of the beam in place p (place vector) in the z direction, g - attenuation coefficient (sum of scattering coefficients [m^{-1}] and absorption [m^{-1}]) [7-15].

The response of biological tissue to laser radiation is due to the interaction of photons and molecules or compounds of biotissue molecules. Atomic and molecular processes and subsequent biological reactions are not yet fully understood [16-22].

Practical realization of optical-electronic system

The study of photoplethysmographic signals can be carried out according to the developed scheme (Fig. 1) (OB - optical emitter (LED) FD - photodetector (photodiode), P - amplifier, ADC - analog-to-digital converter, MC - microcontroller, PC - personal computer, GIU - galvanic isolation unit, SI - serial interface, PC - personal

computer). The device allows to study the tissue microcirculation of the biological object (BO) by illuminating it with a beam of infrared (IR) radiation using an LED, which is partially passing through the tissue or partially reflected from its inner layers, received by a photodetector (photodiode). Pulsations of peripheral vessels caused by the passage of a pulse wave cause fluctuations in the optical density of living tissue, so the infrared radiation flux passed or reflected from the tissues is modulated in amplitude and gives an electrical signal in the photodetector proportional to this flow.

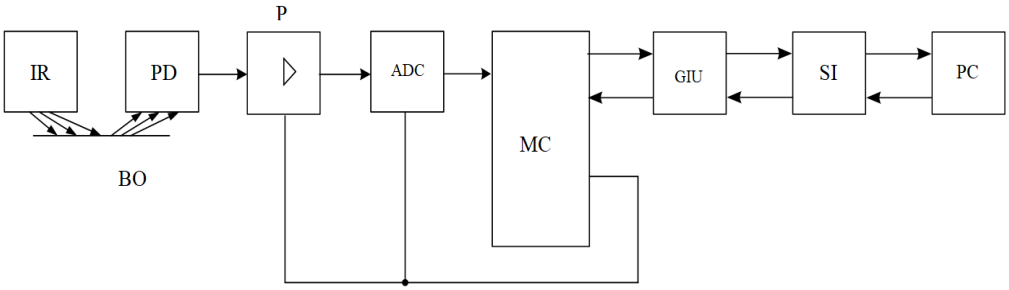

Figure 1. Scheme of realization of optoelectronic system for diagnosing peripheral blood circulation

Results of experimental studies

Clinical examination of patients was conducted on the basis of the Department of Surgical Dentistry and Maxillofacial Surgery of Vinnytsia M.Pirogov National Medical University. The research was carried out in compliance with the basic provisions of the "Rules of ethical principles of scientific medical research with human participation", approved by the Declaration of Helsinki (1964-2013), ICH GCP (1996), EEC Directive № 609 (dated 24.11.1986) , Orders of the Ministry of Health of Ukraine № 690 dated 23.09.2009, № 944 dated 14.12.2009, № 616 dated 03.08.2012.

On the third day, the mean baseline value of the microcirculation level (H) increased by 69.1% ($p < 0.05$) (day 3) relative to the value of the microcirculation (H) on the first day. On the seventh day the average initial value of the microcirculation level (H) compared to the third day decreased by 27.9% ($p < 0.05$) on the third day (7 days), on the 14th day the average initial value of the microcirculation level (H) almost correlates with respect to the value of microcirculation (H) on the first day by 94.3% ($p < 0.05$), which allows us to conclude that the rapid recovery of the level of microcirculation, which almost correlates with this indicator of the first group.

The average initial value of the microcirculation level (H) in relation to the value of the microcirculation (H) before the photon procedure (increase in blood microcirculation by 26.7%) ($p < 0.05$) (1 day) The average initial value of the microcirculation level (H) in relation to the value of microcirculation (H) before the photon procedure (increase in blood microcirculation by 41.6% ($p < 0.05$)) (3 days). Photon procedure (increase in blood microcirculation by 53.5%) ($p < 0.05$) (7 days) The average initial value of the microcirculation level (H) relative to the value of microcirculation (H) before the photon procedure (increase in blood microcirculation by 47.7%) ($p < 0.05$) (14 days), this indicates the effectiveness of photon radiation on the restoration of tissue microcirculation (fig. 6).

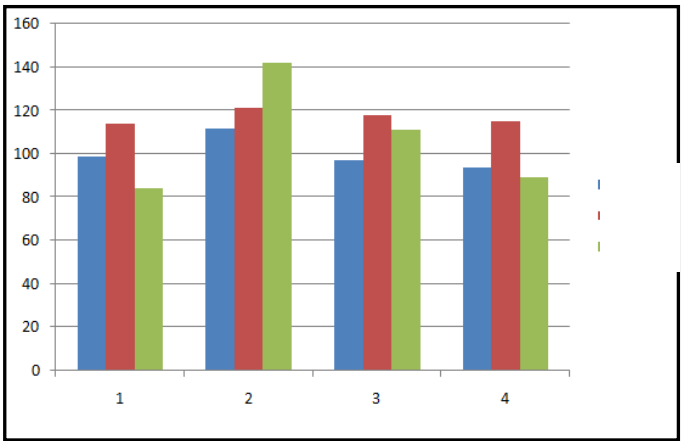

Figure 6. Comparative evaluation of three groups (Group I - without diabetes and without treatment,

Group II - diabetes and without treatment, Group III - diabetes and treatment)

The effect of photon radiation on the studied indicators in patients of group 3 on the average initial value of the microcirculation level (p <0,05) (fig. 7)

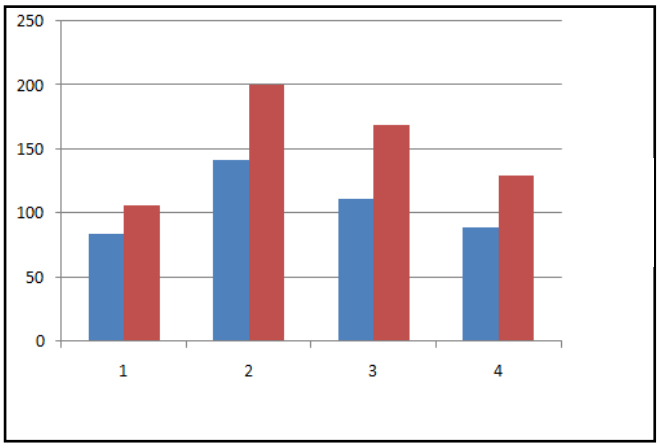

Figure 7. Effect of photon radiation on the studied indicators in patients of group 3 on the average initial value of the microcirculation level (p <0,05)

Conclusions

1. Thus, the use of complex treatment in patients of the third group allows to obtain the average initial value of the microcirculation level in relation to the first group with a correlation coefficient of 94.6% (p <0.05) on the 14th day of treatment. At the same time, for the second group the average initial value of the microcirculation level increased by 14.3% by more than 14 days (p <0.05), respectively, of the first group and 29.2% (p <0.05) - the third, indicating slow healing and restoration of the level of tissue microcirculation.

2.. It is shown that photon radiation increases the elasticity of blood vessel walls, elasticity of erythrocytes, oxygen transport function of blood, activity of cell membranes, acceleration of tissue regeneration, reduction of lipid oxidation, normalization of blood rheology.

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