Coagulation Properties of Incoherent Optoelectronic Systems

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Abstract - **This article presents the results of the experimental and computational study on the development and using of the optical incoherent thermal radiators as a method to control bleeding in surgery The experimental data facilitated the development of the device for photo optical coagulation. The device was successfully tested on animals.**

Keywords - **high-temperature method of coagulation, incoherent optic electronic systems, medicine, experiment**.

I. INTRODUCTION

High-temperature technology, which is used in surgery for hemostasis, is based on the principle of protein coagulation. According to the research and personal experience, it is possible to state that there is no technology without any shortages and failings that could absolutely satisfy the requirements of modern surgery [1].

II. MATERIALS AND METHODS

In order to optimize the development of photo-medical technologies, the calculation and experimental investigation of the possibilities thermal optical incoherent radiators was carried out in the aspect of a compact manual and stationary devices for high-temperature coagulation in surgery. It is established that the efficiency depends on temperature dynamics in the area of curing which can be estimated eq. 1:

$$T_1 = T_0 + \frac{\alpha \bullet E_E - qnk}{a \ K}\left[1 - e^{\left(\frac{a \ \delta}{cj} t_I \right)} \right] \qquad (1)$$

T_1 is the temperature at time t_1 at the begin of curing [K]; T_0 is the initial temperature of the irradiated object [K]; ά is the coefficient of radiation absorption; E_E is the level of the radiation in the working area of the irradiated object [W/m2]; q is mass of the irradiated object per unit of its irradiated surface [kg/m2]; n is the latent heat of evaporation [W×s/ kg]; k is the ratio between the total body surface area and the radiation surface; c is the specific heat capacity of the radiated object [W×s/kg]; d is the ratio between the total the body surface area and its volume [m^3]; j is density of the radiated object; a_Σ is the total coefficient of heat diversion of the radiated object [W/m^2 K] [2]. One-time usage of a common (if necessary preliminary heating) and controlled irradiation focusing on the irradiated object was proposed to expand the possibilities of optical curing. Based on the calculated results and formulated principles, the experimental models of hyperthermic coagulation devices were constructed. They are based on the concentrated radiation. In the first stage of the experimental study the thermoplastic object was used for radiation in order to determine parameters of the device capacity. The temperature dynamic in the working area of the irradiated object, the effect of voltage on the temperature and its allocation on a spot of heat treatment were researched. The second stage consisted of the experimental operations, aimed at the implementation of the final hemostasis during the resection of parenchymal organs.

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III. RESULTS AND DISCUSSION

Established the nonlinear correlation between the radiation time from the moment of the switching-on of the incoherent radiator to the begin of the phase transition of the thermoplastic material. The experimental data on the temperature distribution in the radiation area of the radiated object for the reflector with a diameter of 50 mm suggests that the sizes of the high-temperature zone (1,5 – 3,0 mm) coincide with ones calculated by a mathematical model. Use of the hyperthermic coagulation devices based on the infrared concentrated radiation has shown their efficiencies in all types of experimental surgeries. To achieve hemostasis the dry surface of the organ is not required; the liquid part of blood is a subject of coagulation, which acts as a stopper of capillary bleeding. During this process the organ parenchyma is not exposed to the destructive effects of heat due to the thermal-insulating properties of the formed coagulation envelope.

IV. CONCLUSION

Presented above the preliminary results of computed and experimental studies on the design and use of the optical incoherent radiators to achieve hemostasis show a great future prospects of these technologies in medical practice.

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