USE OF VISIBLE ELECTROMAGNETIC WAVES IN THERAPY OF PRECANCEROUS GASTRIC DISEASES

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In this paper we discuss prospects of using non-laser visible radiation in therapy of precancerous gastric diseases through blood irradiation. High potentialities of such a treatment lie in the mechanisms of biological action of low-energy He-Ne *laser radiation which have been understood based on a vast material of clinical observations. The study of absorption and fluorescence spectra of blood enabled us to conclude that the primary acceptors of the* He-Ne *laser radiation are molecules from the series. The absorption of light by porphyrins results in the chain processes of membrane oxidizing, through a series of physicochemical reactions, whose products, in their turn, make the specific and non-specific anti-oxidant defense systems active. Irradiation of blood by visible electromagnetic radiation, from non-laser light sources, produces a positive clinical and endoscopic effect. As in the case with intravenous laser irradiation of blood it also exhibits a correcting influence on the precancerous changes in stomach.*

The stomach cancer is one of the most widely spread among the oncological diseases. Regardless of the tendency to a decrease in the number of patients with this disease the development of measures of secondary prophylaxis is still an urgent problem. One of the reasons for that is, for instance, the fact that the degree of neglect of this disease is the highest among the patients who apply to a hospital for the first time. As a consequence, about 58% of such patients die during a year after the disease has been revealed.

Among the secondary prophylactic measures there are treating the diseases or correction of the processes that precede the neoplastic growth. In the case of stomach cancer those could be chronic atrophic-hyperplastic gastritis and ulcer. It should be noted that here important are not the diseases themselves, but their combination with the break of the processes of proliferative activity and differentiation between the cells of different types of dysplasia.[1,2]

The methods of ulcer treatment are permanently being discussed in the literature and improved. Recently, there has been achieved a better understanding of this disease as well as new methods for its treatment developed. Much attention is being paid in these studies to physiotherapeutic methods and, in particular, to the phototherapeutic ones.[3,4,6] A lot of modern anti-ulcer medicaments provide for cicatrization of the ulcer defect while, at the same time, not always this is accompanied by a regression in the dysplastic process. However, it is just this process that is most dangerous as a background for or a source of a cancer tumor growth.

Laser radiation of the medium and high power is being more and more widely used in surgery and oncology. The method of photodynamic therapy is the one that is studied and developed best of all. It is based on the ability of cancer tumors to selectively compile endogenic and exogenic porphyrins that can be affected by laser radiation thus enabling destruction of the cells with pathological changes.[11]

At present it is proved that the tissues with dysplastic changes are also capable of compiling the porphyrin compounds. This circumstance shows much promise for treating and curing some precancerous diseases, taking into account known photodynamic therapy mechanisms.[10] According to this understanding it seems to be quite possible to use low-energy laser radiation to cure epithelial dysplasia.

As it follows from literature and from the investigations we have carried out earlier, the mechanisms of the selective photodynamic therapy and those of a system action on blood, like the intravenous laser irradiation,[5,8,9] are much the same. The matter is that in both cases the acceptors of visible light are porphyrins, porphyrin containing substances, and molecular oxygen. Absorption of photons can cause, in membranes, as a result of photo-oxidation reactions (photodissociation, photodynamic and photovoltaic effect) involving the oxygen and oxygen active molecules, the chain, free-radical reactions with unsaturated fatty acids. Moreover, through this mechanism, the absorption of a photon may stimulate the anti-oxidant defense system because of the corresponding changes in the viscosity and

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penetrability, as well as of the electrochemical potential strength of the membranes.

The blood irradiation results in an enhancement of non-specific resistance and stimulation of the anti-stress mechanisms at the molecular, system, organ and organism levels. As a consequence a correction may be achieved for the homeostatic shifts that are the most important pathogenic factors in the stomach ulcer disease.[1,2,7] The intravascular laser irradiation of blood gives quite encouraging results on cancellation of the clinical manifestations of the disease and on the regression of morphological disarrangement, like dysplasia, as well.

As known, the main specific features of laser radiation are its spatial and temporal coherence and monochromaticity. However, when passing through tissues and blood, the laser beam inevitably looses its coherent properties. Moreover, while traveling through an optical waveguide, the beam changes its power as well. In this connection we have arrived at a conclusion that the above mentioned properties of a laser beam are not decisive for producing a biological effect, rather the wavelength of radiation is.

Thus, if it is so, one may achieve the same biological effects using the sources of incoherent radiation that emit at similar wavelengths and have the emission power comparable to that from a laser. The history shows that yet in the beginning of this century the light, naturally from non-laser sources, of the ultraviolet and red regions was successfully used to cure various diseases. Moreover, now this method is being implemented into the clinical practice to irradiate the circulating blood through the skin.

Taking the above considerations into account we have developed a technique and designed a therapeutic device for irradiating the circulating blood with the emission of light emitting diodes in the red portion of the visible spectrum. Use of this installation enables creating the same light power inside a vasculum as from a laser source.

METHOD OF INVESTIGATION AND MATERIAL

To demonstrate the feasibility and make a comparative analysis of the efficiency of laser and non-laser irradiation of blood with visible radiation we have carried out a clinical study in three groups of patients. The first one included 30 patients with the stomach ulcer disease that received a complex medicamental therapy (antacids, H-blockaders, reparative medicine). Second group of 32 patients have received, along with the complex medicamental therapy, the intravascular laser irradiation of blood. The third group of 33 patients have been treated with the blood irradiation by visible radiation from a non-laser wide-band light source, in addition to the complex medicamental therapy. In all cases we have been recording the dysplastic changes, of the 2nd and 3rd degree, in the epithelium of the stomach mucosa.

In our investigation we have placed special value on the study of general adaptation syndrome, stress-stimulating and stress restricting hormones, immunological status, as well as on the indices of the circulating blood state. These indices are being determined using conventional techniques. The efficiency of therapy applied to patients has been estimated using fibergastroduodenoscopy (FGDS).

TECHNIQUE OF BLOOD IRRADIATION WITH A BROAD-BAND LIGHT SOURCE

To irradiate blood we used a MITS FOTON–03 universal device that enables the external and intracavitary magnetic and laser irradiation, as well as the irradiation by light emitting diodes. Specifications of this therapeutic device are as follows.

Specifications of the MITS FOTON–03 device

Wavelength of pulsed radiation	0.89 ± 0.01 μm
Wavelength of continuos wave radiation	0.66 ± 0.015 μm
Pulse power	4–8 W
Maximum power of cw radiation in the red portion of spectrum	25 mW
Power consumption	≤ 10W
Voltage	220 V

During the treatment a patient was sitting on a chair. The irradiation has been done of the projection of vascular bundle (vascular bed of the cubital vein) in the bend of elbow. One seance lasted 30 minutes at the power of radiation in the vascular bed of 4.1 ± 0.1mW. The treatment has been given once a day during 6 or 7 days.

TECHNIQUE OF INTRAVASCULAR BLOOD IRRADIATION

To provide for intravascular laser irradiation of blood we used a standard LT–92 therapeutic device. Its specifications are as follows.

Specifications of the LT–92 laser system

Wavelength of radiation	0.63 μm
Radiation power	≥ 12 mW
Exposure time	1 to 99 min
Power consumption	45 W
Voltage	220 V

After preparing the device for operation a puncture of the cubital vein is made in a patient who is lying on his/her back. Then we introduce, through a syringe needle, an optical waveguide into the vein so that the end of the waveguide is 0.5 to 1cm from the needle end.

RESULTS AND DISCUSSION

In the course of the therapy provided for the patients we have recorded certain positive dynamics in

patients of all the three groups. However, the regression of the main clinical-morphological disarrangement has started earlier in patients who received blood irradiation, either intravascularly with a laser or through the skin by radiation from a broad-band light source, as compared to those who received only the medicamental treatment.

The efficiency of treatment has been assessed using the data of fibergastroduodenoscopy. Thus, a complete cicatrization has been recorded on the 14th day in 42% patients from the first clinical group (medicamental treatment only). In the second group of patients (medicamental treatment plus intravasculary blood irradiation with a laser) this result has been achieved in 86%, while in the third group of patients (medicamental plus blood irradiation with a broad-band emission) it was 83%. Regardless of the radiation type in about 95% patients there was achieved complete cicatrization while in the first group this happened only in 73% patients.

Thus, we have revealed that the cancellation of clinical symptoms and cicatrization of the ulcer takes place much earlier in patients who received photodynamic therapy in combination with the medicamental one. We have also established that no drastic difference is observed between the method of intravasculary blood irradiation with a laser and a broad-band source, provided that the wavelength of radiation is the same. As it follows from the results of our study with the red light the indices of the vegetative supply of functions, hormonal, immunological status, and the state of peripheral blood are the same regardless of the fact which light, coherent or incoherent, is used for the blood irradiation.

Thus, the theoretically proved assumption that coherence of visible light is inessential for producing a therapeutic effect has been confirmed in practice, when treating patients with the stomach ulcer disease. This circumstance is very important since now we have better grounds for a wider clinical use of treatment methods that are based on blood irradiation with visible electromagnetic waves from broad-band light sources.

Moreover, this approach has a number of advantages as compared to the method of intravascular laser irradiation of blood. The first one is that this method is noninvasive, easy to use, and very inexpensive, in contrast to the laser technique, while, at the same time, showing all the positive effects of the phototherapy.

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