TREATMENT AND PROPHYLAXIS OF POSTOPERATIVE COMPLICATIONS IN ONCOLOGIC PATIENTS USING A "MALAKHIT" LASER INSTALLATION

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This paper presents some results on irradiation of experimental animals with vaccinated tumors by low intensity laser radiation. A He–Ne laser and a copper vapor laser were used for this purpose. Radiation from the helium–neon laser was found to stimulate both the size of tumor and the number of metastases. On the other hand radiation from the copper-vapor laser oppressed tumor growth and had a distinct antimetastatic effect what prolonged the life of animals.

The currently available information about the effect of low–intensity laser radiation on the development of tumoral process is contradictory. There are reports on both the growth of ascetic carcinoma cells stimulated by laser action[3] and inhibition of tumor development.[1,4,5] Such ambiguous results can most probably be explained by the fact that experimenters use different modes of laser radiation. Indeed, it is known that photoregulation of cell metabolism is only triggered within narrow dosing intervals of irradiation.[2] This situation apparently calls for careful experimental studies of different types of lasers covering a wide range of radiation modes in anticipation of applying low-intensity lasers to oncologic clinic.

This paper presents some experimental results on the effect of laser radiation of different wavelengths on tumor development.

EXPERIMENT

We used 175 non–inbred white rats of both sexes weighing up to 180–200 g, 80 non–inbred male mice and 355 mice of the C57B1/6 line and HI hybrids weighing up to 20–25 g for our experiment. Tumors (Pliss lymphosarcoma, solid Erlich ascetic carcinoma, Luis pulmory adenocarcinoma) were hypodermically re-vaccinated following the standard procedure, as 199 medium shots to animal's right flank (lymphosarcoma, carcinoma) or intramuscularly into the right hind paw (pulmary adenocarcinoma).

Three to five times daily irradiation of depilated skin above the tumor was started 7–11 days after vaccination. The Malakhit and LG–75 lasers were used. The Malakhit Cu-vapor laser generates pulses 20–30 ns long at a 15–22 kHz frequency. Generating at two transitions, the laser beam contains two spectral lines: a green and a yellow (578.2 and 510.6 nm) at a ratio of 3:1. The LG–75 continuous mode laser generates a red spectral line at 633.6 nm. To act on a tumor the laser radiation power density was held at 0.09–0.15 W/cm^2 and an output power 50 to 150 mW.

The reference group of animals was composed of those with re-vaccinated tumors not irradiated with laser emissions. To estimate the dynamics of tumor growth we measured three mutually perpendicular diameters and calculated tumor volume by the formula $V = A \times B \times C \times \pi / 6$. Propagation of the metastases was estimated from their average number per single animal and from the diameter of metastases. To determine the toxic effect we calculated weighting factors of inner organs, the number of leukocytes and erythrocytes in peripheric blood, and the lifespan of animals.

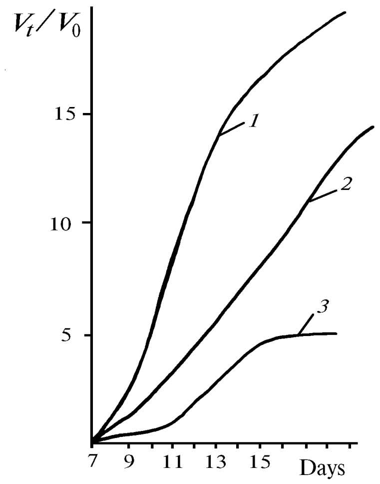

FIG. 1. Effect of laser radiation on the growth of Pliss lymphosarcoma. 1) 633 nm *wavelength, 2)* 578 nm*, 3) no irradiation (reference).* V_0 *is the initial volume and* V_t *is the volume of tumor at the time t.*

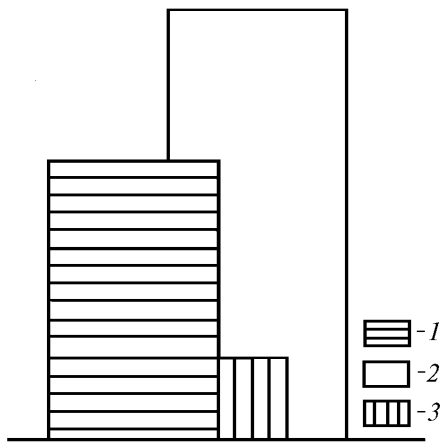

FIG. 2. Effect of laser radiation on metastasic spread of Luis pulmory adenocarcinoma. 1) reference group (no irradiation), 2) irradiation at 633 nm *(red), and 3) irradiation at* 578 nm *(green–yellow).*

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RESULTS

Our study results indicated that irradiating the Pliss lymphosarcoma of rats from a laser generating at 633 nm resulted in a distinct stimulation of tumor growth: the volume of lymphosarcoma increased by a factor of 25 as contrasted to a 5–fold growth of the same tumor in the reference group within the same period (Fig. 1). Special attention was driven to the inversely proportional dependence of the rate of tumor growth on its size prior to irradiation: the smaller the initial volume of the tumoral node, the more pronounced was the effect of stimulation. Simultaneously the process of metastasic spread intensified: either the mean mass of metastases per single animal increased from 225 mg in the reference group to 507 mg ($p < 0.05$), or the rate of metastasic spread accelerated by 40%. Survival of animals also decreased: 80% of the reference rats remained alive by day 18 after tumor re-vaccination, and while only 50% were still alive in the group taking laser irradiation ($p < 0.05$).

When irradiating the tumor from a Cu–vapor laser its volume increased by a factor of 15, the mass of metastase averaging 195 mg, which did not differ from reference values. The rate of metastasic spread remained at the reference level or even lowered by 25% ($p = 0.05$). However when power density was increased to 0.14 W/cm^2, a plausible 50% increase in metastasic spread of lymphosarcoma was detected.

Variations in weighting factors of internal organs of animals in the reference groups were typical for a stress reaction: for adrenal glands the factor increased by 43% and the factors for spleen and thymus lowered by 44% and 49%, respectively ($p < 0.01$). The number of leukocytes in peripheric blood of animals did not change during experiments. Meanwhile irradiation at 633 nm resulted in a reduction of the number of erithrocytes by a factor of 1.8 ($p < 0.01$).

Applying the Malakhit laser at the same power density (0.1 W/cm^2) and irradiation dose (30 J/cm^2) resulted in a pronounced reduction of carcinomic development in rats with Erlich carcinoma. Inhibition of tumor growth on the fifth day of treatment was 79%, on the ninth day reaching 85%, and 83% on the 28th day, as compared to reference, i.e., the effect was not short–lived and held for at least a month. By that date the survival of animals in that group was twice as high as in the reference group.

Irradiating the C57B1/6 and hybrid H1 mice with Luis pulmory adenocarcinoma tumor growth was retarded 40-63% ($p < 0.01$) by day 21–22 after re–vaccination. The number of pulmory metastases substantially decreased, by a factor of 2.5–3 depending on the extension of irradiation on tumored node. Late treatment (starting at 2.0–2.4 cm^3 initial volumes of adenocarcinoma), resulted in weaker antitumoral and antimetastatic effect; however it reached 33 and 47%, respectively, even then. Irradiation at the red laser wavelength resulted in speeding up the processes of pulmory metastasic spread by 163%; no antitumoral effect was detected (Fig. 2).

The results obtained make possible the following conclusions:

1. A laser operating at red wavelengths has a pronounced stimulating effect on the growth of lymphosarcoma in rats (inversely proportional to tumor size at irradiation) and on the processes of lymphogenic and hematogenic metastasic spread (the latter found in C57B1/6 mice). A reduction of animals' life is also observed against the background of pronounced stress reactions.

2. A laser operating at green-yellow wavelengths retards the growth of Erlich carcinoma and pulmory adenocarcinoma in rats, the effect holding for a month and prolongs the animals' life. An apparent reduction of the number of pulmory metastases is simultaneously observed.

3. The effect of low–intensity laser irradiation on the development of heterogenous and syngeneous tumors in experimental animals depends on the species, type of tumor, laser radiation wavelength, and power density.

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