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Immunotropic Action of Nonlaser Monochromatic Radiation

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It is shown that infrared or monochromatic red light from a novel device stimulates immune processes and nonspecific resistance in mice.

Key Words: *infrared light and monochromatic red light; immune system*

Low-intensity helium-neon lasers [1-3] (for example, semiconductor *Uzor* lasers [4]) have found wide application in clinical practice. In recent years, monochromatic radiation has been successfully used in the treatment of some diseases. Unfortunately, its effects have not been studied in sufficient detail in experiments, and clinical application in most cases remains empirical. Here we report the data on the effects of infrared light (IRL) and monochromatic red light (RL) generated in a KRIK-ED-57 apparatus on the immune system and nonspecific resistance of mice. Red light has a wavelength of 0.66-0.68 μ and penetrates deeper (1.5 cm) into living tissues than does the light from a helium-neon laser (0.5 cm). The wavelength of IRL (0.89 μ) is the same as that of the radiation from an Uzor laser, but its mean power (not less than 150 mW), which determines the absorbed radiation dose, is five times as high as that from an Uzor laser (30 mW).

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MATERIALS AND METHODS

The study was conducted on (CBA×C57Bl/6) F_1 mice and noninbred mice weighing 16-18 g. A KRIK-ED-57 apparatus provided monochromatic infrared and red light at a power flux density of 10 mW/cm^2 for IRL and 1 mW/cm^2 for RL.

In order to assess the effects of IRL and RL on the humoral immune responses the area of the sternum projection was irradiated for 1 or 2 min once or three times, after which splenic antibody-producing cells were identified by local hemolysis in gel [5]; serum titers of hemagglutinins and hemolysins were determined by conventional methods and expressed as natural logarithm.

The effects of IRL and RL on cell-mediated immunity were assessed using the delayed hypersensitivity test [6]. The thymic area was irradiated for 1 min once or three times within a 24-h period before sensitization or once before challenge with sheep erythrocytes. Intact mice served as the control.

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TABLE 1. Effects of Red and Infrared Light on Humoral Immunity

Parameter	Control (intact mice)	Irradiation time, min			
		single session		three sessions	
		1	2	1	2
Red light					
No. of antibody-producing cells per spleen	11707±2295	18395±2233*	12728±1572	15872±1267	12800±4364
Hemagglutinin titer	5.32	7.32	7.32	6.32	7.32
Hemolysin titer	5.32	8.32	7.32	8.32	8.32
Infrared light					
No. of antibody-producing cells per spleen	19680±3850	14293±2100	15116±3650	38362±4300*	27762±3846
Hemagglutinin titer	5.32	6.32	6.32	6.32	6.32
Hemolysin titer	5.32	7.32	7.32	8.32	6.32

Note. Here and in Table 2: *$p<0.05$ in comparison with the control group; each group consisted of 12-15 mice.

The effects of IRL and RL on the phagocytic activity of peritoneal polymorphonuclear leukocytes (PMNL) were assessed in mice irradiated for 1 min and infected after 24 h with *Yersinia pseudotuberculosis* in a dose of 5×10^8 microbial bodies. At 1, 5, 15, and 24 h postinfection, cells were counted in peritoneal exudate, and the percent of phagocytizing PMNL (phagocytic index) and the mean number of microorganisms ingested per leukocyte (phagocytic number) were calculated.

The data were analyzed using Student's *t* test.

RESULTS

Both generation of antibody-producing cells and antibody production increased in mice irradiated with RL once for 1 min 24 h before immunization: the number of antibody-producing cells per spleen increased 1.6-fold ($p<0.05$), and serum antibody titers increased by 2-3 dilutions relative to the control levels (Table 1).

Infrared light also stimulated the humoral immune response, particularly after three 1-min sessions during the inductive phase of antibody production: the number of antibody-producing cells per spleen almost doubled ($p<0.05$) (Table 1).

The observed stimulation of humoral factors of immunity during the inductive phase of antibody production (i.e., before direct contact with antigen) indicates that RL and IRL influence the antigen-induced transformation of B lymphocytes into antibody-producing plasma cells.

The data on the effects of RL and IRL on cell-mediated immunity estimated in the delayed hypersensitivity test are shown in Table 2. Neither single nor multiple irradiation with RL before sensitization caused any statistically significant change in this reaction, whereas with IRL both regimens significantly increased it ($p<0.05$). A single exposure to RL or IRL before challenge with sheep erythrocytes less effectively stimulated the reaction than the multiple exposure, although RL produced a statistically significant effect ($p<0.05$).

Consequently, RL enhances the delayed hypersensitivity response by acting predominantly on mature effector cells, while IRL acts on the precursors of

TABLE 2. Effects of Red and Infrared Light on Delayed Hypersensitivity

Irradiation regimen	Increase in paw weight (%)	
	red light	infrared light
Before sensitization		
single session (1 min)	9.9±0.9	16.8±2.2*
three sessions (1 min each)	8.1±1.5	16.1±1.0*
Before challenge (single 1-min session)	13.2±1.4*	11.5±2.2
Control	9.4±1.1	

effector T cells. Both RL and IRL stimulated peritoneal PMNL, which accelerated the abdominal cavity clearance from yersinias: the microorganisms were eliminated within 24 h. In control mice, 5±0.2% of PMNL were active: the phagocytic number was 0.2± 0.01. One hour after infection, the phagocytic index in mice irradiated with IRL and RL was 34.3±5.1% and 24.7±2.2%, respectively (*vs.* 13.3±1.2% in the control), and the phagocytic number was 1.02±0.02 and 0.6±0.03, respectively (*vs.* 0.26±0.02 in the control). Thus, the effect of RL on phagocytosis was weaker than that of IRL.

Five hours after infection, the microbes were actively digested by PMNL of irradiated mice, while in PMNL of control mice they actively divided. The phagocytic activity of PMNL in experimental mice remained elevated throughout the observation period (3 weeks).

Thus, IRL and RL stimulated phagocytosis of *Yersinia pseudotuberculosis* by peritoneal PMNL.

In the present study, we have identified the immune system components which may be effectively influenced by red and infrared light. Together with results of clinical trials, these findings open prospects for the use of KRIK-ED-57 apparatus for the treatment of diseases accompanied by secondary immunodeficiencies.

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