EFFECT OF HELIUM–NEON LASER RADIATION ON MORPHOLOGY OF EXPERIMENTAL ALLERGIC CONTACT DERMATITIS

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Low-intensity laser radiation, as a new method in physiotherapy, is being used on an ever-increasing scale for the treatment of many different skin diseases. Results of clinical application of helium–neon lasers for the treatment of trophic ulcers, neurodermatitis, eczema, scleroderma, and other dermatoses have been reported [3, 6, 7]. Views expressed previously on the stimulating and anti-inflammatory action of low-intensity laser radiation [2, 4] have not yet obtained a factual basis.

The object of this investigation was to study the effect of helium–neon laser on skin structure in allergic contact dermatitis (ACD), for allergic inflammation, which lies at the basis of many skin diseases, develops during this process in skin-sensitized animals.

EXPERIMENTAL METHOD

Three series of experiments were conducted on guinea pigs weighing 250–300 g. In series I an area of unchanged skin on the lateral surface of the trunk of 9 animals was irradiated with a helium–neon laser (OKG-12, wavelength 632.8 nm) for 3, 5, and 10 min daily for 5 days with a power density of 8-10 mV/cm^2. In series II, ACD was induced in 10 guinea pigs by application of 2,4-dinitrochlorobenzene (DNCB) to the skin by the scheme described previously [5]. Areas to which DNCB was applied were irradiated with a helium–neon laser, with the parameters mentioned above, for 5 days after application of the sensitizing dose of DNCB also. Animals of series III served as the control to series II: DNCB dermatitis was induced in 10 animals but they were not irradiated with the helium–neon laser. Skin reactions to application of DNCB were assessed macroscopically 24 h after the reacting application: +) slight erythema, ++) moderate erythema, +++) intense erythema and edema, ++++) intense erythema and induration.

Skin biopsy was performed on the animals of series I 24 h after the last irradiation, and in series II and III 24 h after application of the reacting dose of DNCB, i.e., on the 15th day. Pieces of skin for histological study were fixed in acetone, embedded in paraffin wax, and stained with hematoxylin and eosin. Biopsy material for electron-microscopic study was fixed in glutaraldehyde, postfixed in OsO_4, dehydrated in alcohols and propylene oxide, and embedded in Epon and Araldite. Sections were cut on an LKB ultrotome and examined and photographed in the IEM-100S electron microscope.

EXPERIMENTAL RESULTS

Macroscopic study of normal guinea pig skin in areas of irradiation by helium–neon laser (series I) showed no visible changes in areas exposed to the laser.

The histological study showed that irradiation of normal skin by helium–neon laser causes slight acanthosis, slight capillary dilatation, and an increase in the cellular response in the dermis due to proliferation of fibroblasts. Increased density of the cytoplasm of the epidermocytes, especially the basal cells, was found electron-microscopically, due to an increase in the number of ribosomes and polysomes. Ultrastructural signs of intensification of protein synthesis also were found in cells of the dermis — macrophages, lymphocytes, and fibroblasts. An increased number of ribosomes, polysomes, and vesicles with dilated cisterns of the endoplasmic reticulum were found in the cytoplasm of these cells. Increased density

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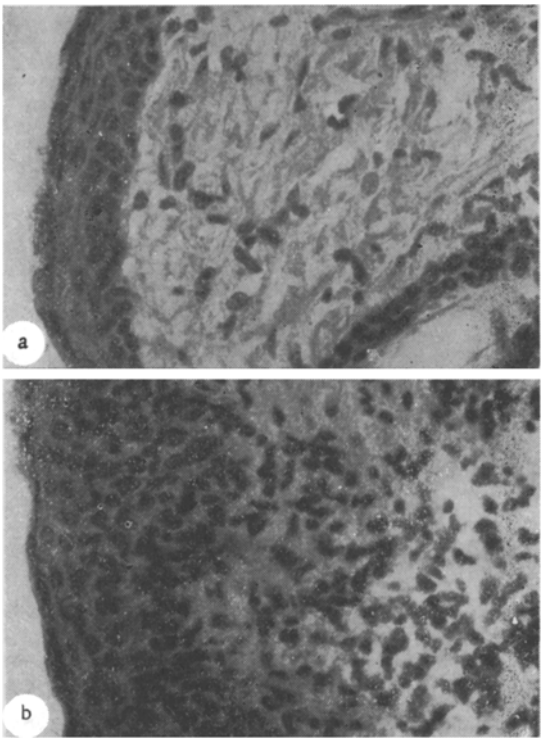

Fig. 1. Skin morphology in foci of ACD in guinea pigs after irradiation with helium–neon laser (a) and without irradiation (b). Hematoxylin–eosin, 200 ×.

of the cytoplasm and an increase in the number of organoids, especially pinocytotic vesicles, were observed also in the endothelial and perithelial cells of the capillaries, both on the side facing the lumen and on the side facing the tissue, evidence of more intensive transport processes.

Evaluation of the effect of the helium–neon laser on the course of ACD (series II and III) showed that the intensity of the inflammatory reaction to repeated application of DNCB, simulating ACD, was reduced by almost half in guinea pigs irradiated with the laser (mean rating 1.8 points) compared with that in the control animals (mean 3.4 points). Considerable differences also were found histologically. The morphological picture of the skin in guinea pigs sensitized and irradiated with the helium–neon laser was similar to normal (Fig. 1a). Slight acanthosis and intensification of the cellular reaction in the true skin were observed, whereas in foci of ACD in control unirradiated guinea pigs considerable acanthosis was observed (Fig. 1b), together with intercellular edema, exocytosis, disturbance of the integrity of the basement membrane, together with edema in the dermis, thickening of the blood vessel walls, and dense infiltration of lymphocytes and histiocytes, intermingled with some mast cells and basophils.

Electron microscopically an increase in density of the cytoplasm of the epidermal cells, an increase in the number of organoids in the cells of the true skin, and considerable pinocytosis in the endothelial and perithelial cells of the capillaries were observed in areas of ACD in animals irradiated by laser, just as in normal skin (Fig. 2a). In the control guinea pigs pinocytosis was not observed in cells of the vessel wall (Fig. 2b).

Macroscopic observations and morphological study thus showed considerable weakening of the reaction of the skin to application of DNCB to sensitized animals under the influence of irradiation by helium–neon laser.

On irradiation of normal skin with helium–neon laser, just as a result of its action on pathologically changed skin in foci of DNCB application, morphological signs of intensification of metabolism were found in cells of the epidermis and dermis, with activation of transport processes in the capillaries. The latter is in agreement with physiological data [1] showing acceleration of the blood flow in vessels of the mucous membrane of the mouth after helium–neon laser irradiation.

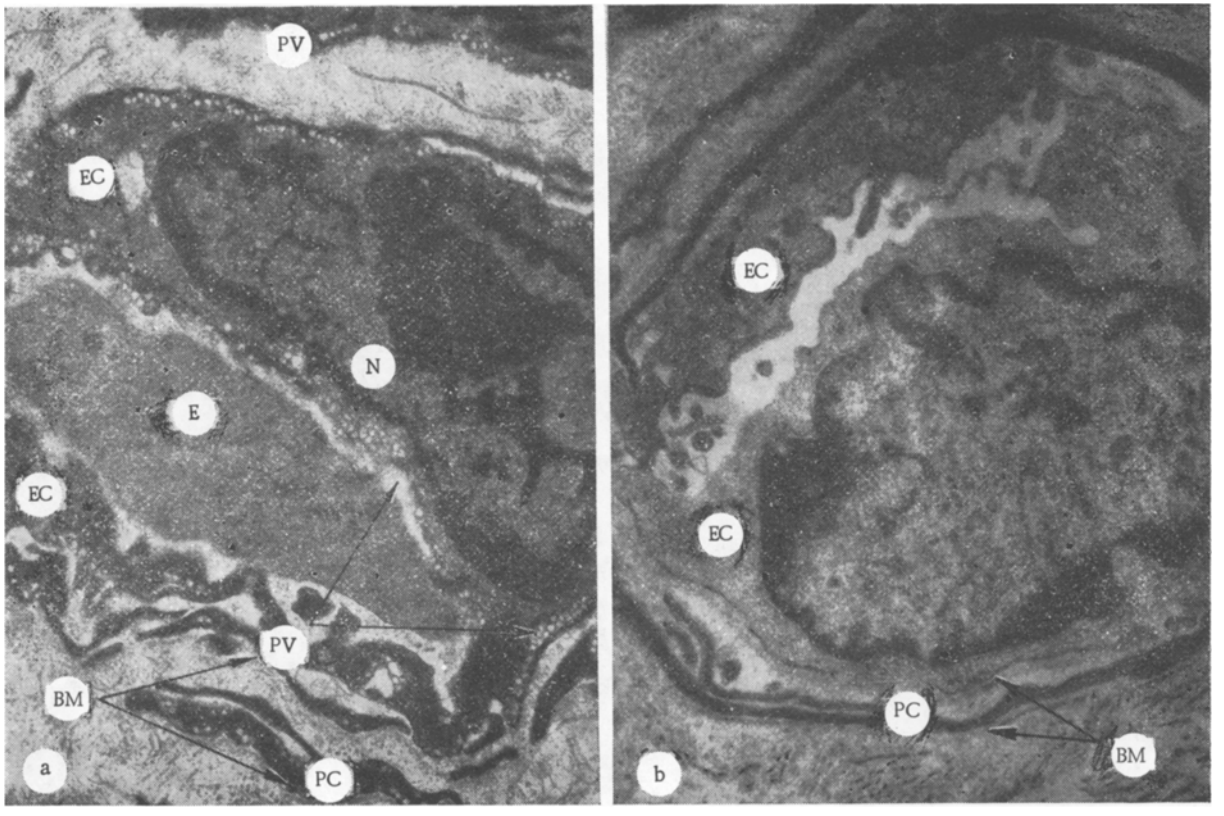

Fig. 2. Capillary ultrastructure in areas of ACD of guinea pig skin after irradiation with helium–neon laser (a) and without irradiation (b); EC) endothelial cells, PC) perithelial cells, N) nucleus, PV) pinocytotic vesicles, BM) basement membrane, E) erythrocyte. 10,000 ×.

Stimulation of transport processes and improvement of tissue nutrition could perhaps contribute to the more effective removal of DNCB–protein conjugates from the focus of application of the hapten, which would lead to weakening of ACD in animals irradiated by laser.

The stimulating effect of the helium–neon laser on cells of the vessel wall, demonstrated by these experiments, leading to stimulation of transcapillary exchange, may be one mechanism of the beneficial therapeutic action of lasers of this type in certain chronic inflammatory skin diseases accompanied by disturbance of the microcirculation and tissue nutrition.

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