# CHANGES IN THE BRAIN AND EYES PRODUCED BY LASERS

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The eyes of 17 chinchilla rabbits were irradiated by a neodymium pulse laser with wavelength 1.06 μ, beam diameter 3 mm, pulse duration 0.003 sec and power from 80 to 160 J. The animals were sacrificed from 2 h to 30 days later and the eyes investigated histologically. Extensive destructive changes of the membranes of the eyes, marked stasis in the blood vessels of the brain, and vacuolation of the cytoplasm of cells of the central visual system were found.

Optical quantum generators (lasers) are now being used in biology and medicine. In particular, in ophthalmology laser beams have been successfully used in the treatment of detachment of the retina and of intraocular tumors and in the creation of an artificial pupil [1, 2, 8, 12, 14].

The biological action of the laser beam has not yet been sufficiently studied, and its effects are largely determined by the properties of organs and tissues [9, 15]. A problem of immediate importance is the application of powerful laser instruments in surgery and oncology [3, 5, 11, 16-18]. The technical aspects of laser radiation also are highly complex. Medical and biological investigations have demonstrated the action of the shock wave and electromagnetic field and the appearance of electrochemical effects in the tissues [3, 13]. During work with lasers attention must also be paid to effects of the beam, both direct and reflected, on unprotected areas of the body and, in particular, on the eye [10]. Various types of protection have been developed in this field: the principles of organization of laser operating theaters have been investigated and protective clothing and glasses introduced [4, 6, 10].

The effects of laser radiation on the brain during irradiation of rabbits' eyes were studied. Only one investigation on this subject could be found in the literature [7]. In this case, when rabbits' eyes were irradiated by a ruby pulse laser with wavelength 0.69 μ and power from 0.001 to 0.05 J, cortical electrical responses in the experimental animals were inhibited.

## EXPERIMENTAL METHOD

The eyes of 17 chinchilla rabbits were irradiated with the radiation focused mainly on the retina. The Soviet neodymium pulse laser (OKG-500) with wavelength 1.06 μ, beam diameter 3 mm, pulse duration 0.003 sec, and power 80-160 J was used. The animals were sacrificed from 2 h to 30 days (at intervals of 5 days) later, the eyes and brain were removed, and histological sections were stained with hematoxylin-eosin and by Nissl's method. The eyes were also studied with an ophthalmoscope.

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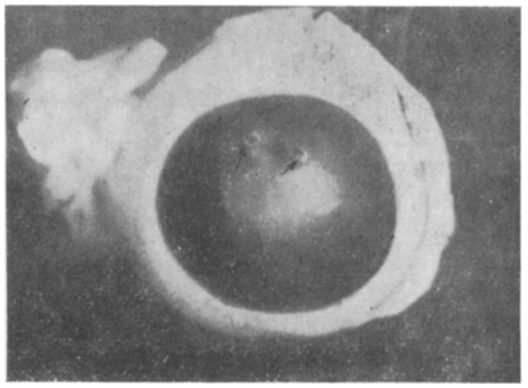

Fig. 1. Vital preparation of a rabbit's eye. Arrows indicate pinpoint opacities in the cornea. Anatomical specimen.

## EXPERIMENTAL RESULTS

Immediately after the laser "shots" pinpoint opacities in the cornea and pericorneal injection appeared (Fig. 1). Extensive opacities appeared in the vitreous and disappeared after 7-14 days. The fundus oculi was occupied by retinal, subretinal, and periretinal hematomas, which were considerably reduced in size on the 15th day. On histological examination on the 1st day after irradiation edema of the cornea, extensive hemorrhages in the iris, and marked destruction in the retina were found. By the 30th day considerable proliferation of connective tissue in the iris was accompanied by the formation of a coarse retrocorneal film and disappearance of the edema of the retinal tissues.

Parallel investigation of the whole of the central visual system revealed proliferation of oligodendroglial cells in the optic tract as early as on the 5th day. The brain arteries were collapsed, but the veins were dilated. Cells with vacuolated cytoplasm and pycnomorphic cells were numerous in the thalamus (Fig. 2). In addition an accumulation of satellite cells (astrocytes) was observed, though they were much less numerous in the corpora quadrigemina than elsewhere in the brain. Area 17 of the cortex showed edema of individual cells, with marked vacuolation of their cytoplasm, and marked stasis in the veins. On the 15th day stasis was still present in the veins at the base of the brain and there was marked edema of the brain substance, with the formation of extensive perivascular and pericellular spaces and the formation of a drainage glia. As a result of proliferation of cells of the marginal row, the ependyma lining the floor of the ventricles appeared to consist of several layers. Because of the edema of area 17 of the cortex, its neurons appeared shrunken, and in some places none could be found. These pathological changes were more marked still in the corpora quadrigemina. After 20 days the edema of the brain substance had increased and more cavities had formed around the nerve cells, with

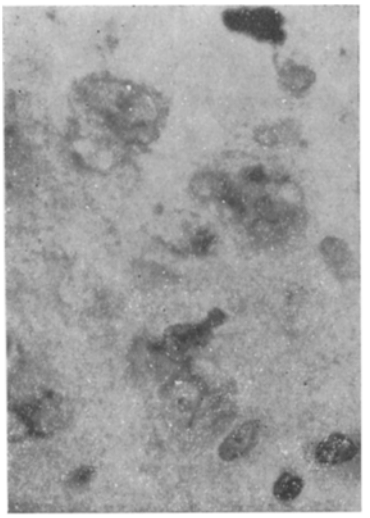

Fig. 2

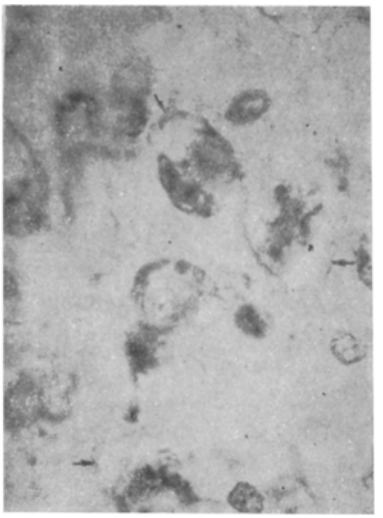

Fig. 3

Fig. 2. Section through the thalamus 5 days after laser irradiation. Cells with vacuolated cytoplasm and pycnomorphic cells can be seen. Nissl, 900 ×.

Fig. 3. Section through thalamus of a rabbit 20 days after laser irradiation. Edema of brain substances. Arrows show formation of cavities around nerve cells. Nissl, 900 ×.

the formation of new pericellular and perivascular spaces and dilatation of the ventricles (Fig. 3). On the 30th day the ventricles also were dilated and vacuolation of the cytoplasm of the nerve cells was clearly defined in all parts of the brain.

The results of these investigations can be summarized by saying that after irradiation of rabbits' eyes by a laser beam, besides extensive destructive changes in the eye membrane, marked stasis of the vessels in the brain is observed, accompanied by vacuolation of the cytoplasm of the nerve cells, progressively increasing edema of the brain substance, dilatation of the pericellular and perivascular spaces, and the formation of a drainage glia.

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