Fig. 1. Energy dose Q required to release a blink reflex, as a function of exposure time t .

Fig. 2. The corneal epithelium with coagulation of the cytoplasm of the basal cells and some superficial cells. Stained with haematoxylin and eosin.

exposure times at fixed values, and long exposures were measured with a stop watch.

The corneal blink reflex seemed to respond in a very reproducible way to exposure to the laser radiation, and so we used it as an indication of a heat sensation in the cornea. In one series of experiments, we measured the time interval between the start of an exposure and the occurrence of a blink, at various levels of beam power. In another series, we determined the time required for visible damage, caused by heat coagulation, to appear on the cornea.

The energy dose, Q , sufficient to release a blink reflex is plotted against exposure time, t , in Fig. 1. In the range 0.01–5 sec the experimental curve follows the relationship $Q = k\sqrt{t}$. This fits a simple thermal model, with heat conduction from the surface as the principal means of loss. The release of a blink reflex then corresponds to a definite increase in the corneal surface temperature. With long exposures, the experimental curve deviates from its theoretical course, and we attributed this to the onset of additional loss mechanisms. At very low levels of power such loss mechanisms will prevent the corneal surface temperature from reaching the value necessary for the release of a blink reflex. In the simplest case we expect at long exposures a t -rather than a $\sqrt{t}$ -dependence.

The experimental curve relating damage dose and exposure time has a similar shape, but the threshold level is roughly a factor of two above the blink reflex threshold. For an exposure time of 1 sec the damage will be barely visible if the delivered energy is 0.3 cal/cm².

Histology of the laser irradiated cornea showed some features typical of threshold damage which are shown in Fig. 2.

We conclude that the radiation from carbon dioxide lasers must be considered dangerous to the eye, because even low power radiation may cause irreversible changes in the cornea, which lead to impaired vision. Reflexes from metal surfaces, which have very high reflectivity at 10 μ m, may be nearly as harmful as the direct beam. Ordinary glasses, with side covers, absorb the radiation and are therefore recommended to all personnel working with these lasers. The blink reflex may offer some protection at very low power levels, but should not be relied on.

K. GULLBERG
E. HARTMANN

Department of Physics,
Research Institute of National Defence,
Stockholm 80.

E. KOCK

Department of Pathology,
Karolinska Sjukhuset,
Stockholm 70.

B. TENGROTH

Department of Ophthalmology,
Sahlgren Hospital,
University of Gothenburg.

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Critical Closing Pressure in Blood Vessels

In considering the control of blood supply to tissues it used to be assumed that the calibre of a blood vessel decreased progressively as tone in the muscle of its wall increased.

In 1951 Burton suggested that, for theoretical physical reasons, there must be a critical level of pressure for each small blood vessel below which the vessel becomes unstable and collapses, thus suddenly closing completely¹. His concept of critical closing pressure was widely adopted and has been applied in biology and medicine ever since. It is quoted in most larger textbooks of physiology and cardiology throughout the world^{2,3}.

Burton thought that the phenomenon explained certain features of shock, of which low blood pressure is characteristic. The concept is fundamental to the understanding of the control of blood supply to vital organs, as well as to the rational management of shock. I therefore wish to point out a fallacy in Burton's logic.

In order that his argument shall stand it is necessary to assume that the muscle in the wall of small blood vessels is able to maintain a constant tension throughout shortening, even beyond the point of zero inert elasticity. But this is not so of muscle in general, and has not been shown to be so in this special case.

Critical closing pressure is therefore not an invariable logical necessity for all small blood vessels, as suggested by Burton. Whether or not it occurs in any particular instance depends on the relation of the Laplacian graph of tension/radius to that of tension/length of relevant muscle. It requires to be demonstrated experimentally in each case.

H. DAINTREE JOHNSON

Experimental Surgical Unit,
Royal Postgraduate Medical School,
Ducane Road,
London.

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