PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

Dependence of the Antiarrhythmic Effect of Laser Radiation on the Rate, Duration, and Site of Exposure

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Acute experiments on cats narcotized with nembutal using the same model of ischemic disturbances of cardiac rhythm reveal that the antiarrhythmic effect of laser depends on the rate and duration of exposure, while its degree of expression depends on the site exposed to radiation.

Key Words: *laser radiation; rate; exposure; irradiation site; ischemic arrhythmia*

An antiarrhythmic effect of laser radiation used for the treatment of ischemic heart disease has been described by many clinicians, but the magnitude of this effect as reported by different investigators varies greatly [2,4,7]. These differences can probably be attributed both to individual peculiarities of coronary circulation in different patients and to the empirical choice of the dose and site of irradiation, since activation of the circulation, inhibition of lipid peroxidation, and rheological properties of the blood, etc. are known to depend on the radiation dose [3]. The above factors have a major impact on the development of the ischemic process in the myocardium and its complications [5].

In view of this the aim of the present study was to elucidate to what extent the antiarrhythmic effect of laser radiation depends on the rate, duration, and site of exposure.

MATERIALS AND METHODS

The experiments were carried out on 34 cats of both sexes weighing 2.5-4 kg. The cats were narcotized with nembutal (40 mg/kg intraperitoneally) and artificially ventilated. Myocardial ischemia was produced by occlusion of the circumflex branch of the left coronary artery near the place of its deviation using a dederon loop and a special fixation devise. The development of ischemic disturbances was observed during 15 min of occlusion and 15 min of reperfusion. This has been shown to result in group ventricular extrasystoles in 50%, ventricular tachycardia in 27.75%, and ventricular fibrillation in 55% of cases [6]. Occlusion of the coronary artery was preceded by a two-time 20-min or 10-min laser irradiation of the right atrium, or, in 10 experiments, the jugular vein. The irradiation was carried out with LGN-208A and ILGI-120 helium-neon lasers (0.63 μ wavelength and 1-2 and 3-5 mW power at the end of the light pipe, respectively) currently used in clinical practice. The power was monitored in each experiment immediately before introduction of the light pipe. The electrocardiogram (ECG) and arterial pressure (AP) in the femoral artery measured using an EMT-35 transducer (Elema) were recorded with P4Ch-02 and Biocomb polygraphs. In the analysis of ischemic complications the development of group ventricular extrasystoles, ventricu-

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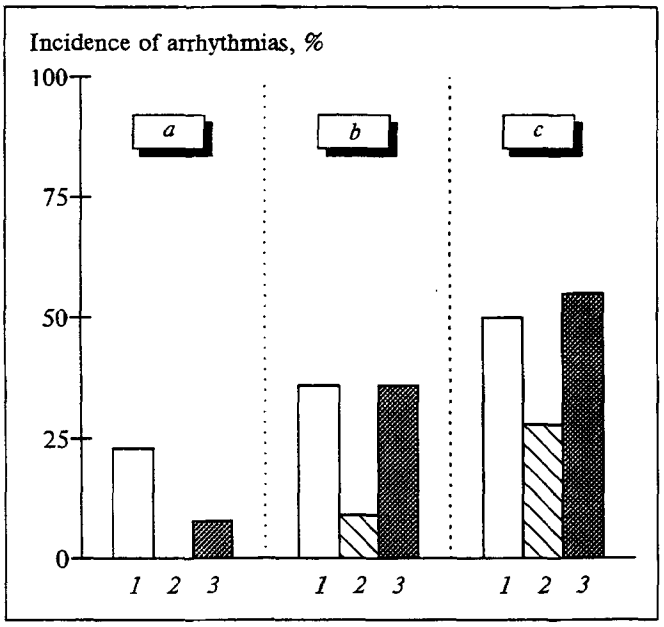

Fig. 1. Incidence of ischemic arrhythmias for intraatrial irradiation (*a*), intravenous irradiation (*b*), and without irradiation (*c*). Here and on Fig. 2: *1*) group ventricular extrasystoles; *2*) ventricular tachycardia; *3*) ventricular fibrillation.

lar tachycardia, and ventricular fibrillation was taken into account. The reliability of the results was evaluated using the χ^2 test.

RESULTS

It was previously shown that a two-time 20-min irradiation of the right atrium with helium-neon laser with an end-pipe power of 3-5 mW considerably reduced ischemic disturbances of the cardiac rhythm: group ventricular extrasystoles occurred only in 23%, ventricular fibrillation in 7.7% of cases, and no cases of ventricular tachycardia were noted [6].

Here we studied the incidence of ischemic disturbances of the cardiac rhythm as a function of the site, rate, and duration of exposure.

In the first series we studied the incidence of arrhythmias after two-time 20-min irradiation of the jugular vein with helium-neon laser at 3-5 mW end-pipe power. Under these conditions the occlusion of the circumflex branch of the left coronary artery in 11 animals (with an initial AP of 146.0±11.7 mm Hg and heart rate (HR) of 193±10.7 beats/min) induced the development of group extrasystoles in 36%, ventricular tachycardia in 9%, and ventricular fibrillation in 36% of cases, i.e., ischemic arrhythmias were less abundant than in ischemia in the absence of laser irradiation, but still more frequent than in ischemia combined with intraatrial irradiation (Fig. 1).

Thus, for the same power and duration of laser radiation the effect is more strongly expressed with the intraatrial route. The atria are known to be very rich in sensitive nerve endings and changes in afferent information from these endings play an important role in the antiarrhythmic effect of laser radiation [6,8]. It may be assumed that the weaker antiarrhythmic effect with intravenous laser irradiation is partially due to the fact that veins possess a lower number of sensitive receptors [1].

On the basis of the fact that the antiarrhythmic effect of laser is pronounced in intraatrial irradiation in the next experimental series we studied the incidence of ischemic arrhythmias for intraatrial irradiation of the same rate and two-time exposure shortened to 10 min (this time corresponds to the start of inhibition of lipid peroxidation and enhanced microcirculation in tissues). These factors are known to play an important role in the development of ischemic damage to the heart.

Under these conditions in 13 cats with an initial systolic AP of 149.8±10.7 mm Hg and HR of 195±9.6 beats/min the occlusion of the circumflex branch of the left coronary artery caused group extrasystoles, ventricular tachycardia, and ventricular fibrillation in 54% of cases (Fig. 2). These data do not differ reliably from those obtained in the absence of laser irradiation, which suggests that shortening the duration of laser irradiation abolishes its antiarrhythmic effect.

In the next experimental series we studied the effect of two-time 20-min intraatrial laser irradiation with an end-pipe power of 1-2 mW on the

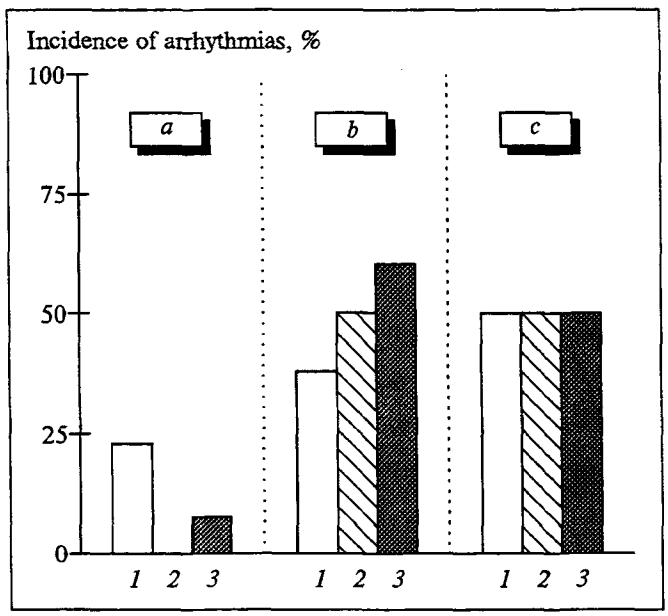

Fig. 2. Incidence of ischemic arrhythmias under conditions of two-time intraatrial laser irradiation with different modes: 3–5 mW for 20 min (*a*); 1–2 mW for 20 min (*b*); 3–5 mW for 10 min (*c*).

incidence of ischemic arrhythmias. Under these conditions in 10 animals (with an initial systolic AP of 136±9.91 mm Hg and HR of 201±11.1 beats/min) occlusion of the circumflex branch of the left coronary artery led to the appearance of group ventricular extrasystoles in 40%, ventricular tachycardia in 50% and ventricular fibrillation in 60% of experiments (Fig. 2).

Analysis of the results demonstrated that in this experimental series the incidence of severe disturbances of the cardiac rhythm was higher than in experiments with irradiation of the right atrium with helium-neon laser with a power of 3-5 mW ($p<0.05$) and did not differ reliably from that obtained previously on the same model without irradiation. This suggests that irradiation of the right atrium with helium-neon laser with a power of 1-2 mW is not sufficient for manifestation of the antiarrhythmic effect of the laser.

The experiments carried out on the same model of ischemic arrhythmia showed that changing the site of irradiation from intraatrial to intravenous diminished the antiarrhythmic effect. Comparison of the antiarrhythmic effect of laser irradiation of the atrium with different rates but the same exposure revealed that lowering the rate reduces the an antiarrhythmic effect. The absence of an antiarrhythmic effect was also observed when the duration of laser radiation was shortened. Thus, the findings suggest that the presence or absence of an antiarrhythmic effect of laser irradiation depends on the rate and duration of exposure, while its degree of expression depends on the site exposed. This should be taken into account in laser therapy.

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