

EFFECT OF ULTRAVIOLET LASER RADIATION ON SMOOTH MUSCLE CELL ACTIVITY IN EXPERIMENTAL INTESTINAL OBSTRUCTION

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The use of ultraviolet (UV) laser radiation in clinical surgery now rests on a firm basis and is a promising development [4]. It has been shown that acute intestinal obstruction (AIO) leads to weakening of the electrical and contractile activity of smooth muscle cells (SMC), and that this depends on the duration of incarceration in the strangulated segment. Function of SMC is restored 3 h after relief of AIO [3]. The use of UV lasers to correct disturbances of motor activity of the gastrointestinal tract in AIO has recently been studied intensively. However, in this pathology the character of responses of intestinal SMC to UV laser irradiation remains unexplained.

The aim of this investigation was to study the effect of UV laser radiation on contractility of SMC of the small intestine in AIO and on their sensitivity to acetylcholine.

EXPERIMENTAL METHOD

Intestinal obstruction was created in mature cats under ether anesthesia by ligating a loop of ileum with its mesentery with kapron thread. The duration of AIO was 3 h. Three series of experiments were carried out 20 h after creation of AIO: I) without UV irradiation; II) with UV irradiation of the strangulated segment of intestine by scanning it sector by sector with the UV laser beam at the rate of 0.5 cm/sec for 5 min. The distance from the end of the light guide to the object was 7 cm. The diameter of the zone of scatter on the object was 2.5 cm. In the experiments of series III, 20 h after relief of AIO, intracorporeal photomodification of the blood by UV laser was carried out through a catheter in the femoral vein for 5 min. The LGI-21 optical quantum generator was used as the source of low-intensity UV laser radiation. The wavelength of the radiation was 337 nm, the pulse repetition frequency 100 Hz, and the average power at the outlet from the light guide was 3 mW. To study electrical activity of SMC a one-section sucrose gap was used [1, 5], and mechanical activity of SMC was recorded in an isolated strip with the aid of a photoelectric transducer [2]. SMC from the longitudinal layer of the afferent, strangulated, and efferent segments of the ileum were investigated. Preparations from the corresponding segments of the intestine of an intact animal served as the control. Acetylcholine iodide in concentrations of 10^{-3} - 10^{-8} M was used as the agonist. The response of SMC was measured in grams (force). The mean effective dose (ED_{50}) was calculated [6]. The results were analyzed by Student's test.

EXPERIMENTAL RESULTS

Afferent Segment (Fig. 1, Table 1). In the series of experiments with irradiation of the ileum contractility reached 53.5% ($p < 0.05$) of the control level, and was 22.9% ($p < 0.05$) below values of contractility without UV

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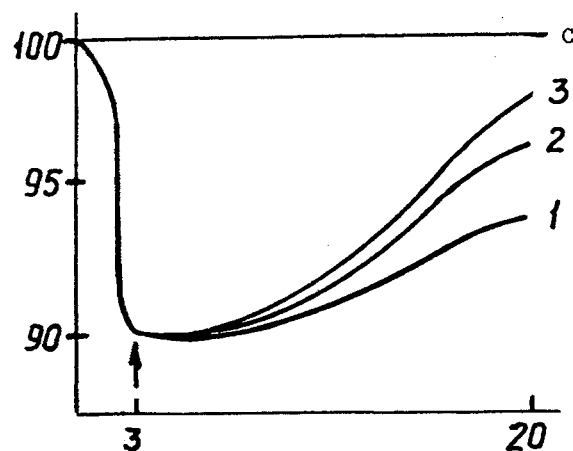


Fig. 1. Sensitivity of SMC to acetylcholine in strangulated segment of cat small intestine. Ordinate, negative logarithms of ED_{50} (in % of control); abscissa, time (in h). Arrow indicates moment of relief of AIO. C) Control; 1) series I, 2) series II, 3) series III of experiments.

TABLE 1. Effect of UV Laser Irradiation on Sensitivity of SMC of Small Intestine to Acetylcholine (negative logarithms of ED_{50})

Experimental conditions	Segments of ileum		
	afferent	strangulated	efferent
Control	6.61 ± 0.06	6.61 ± 0.06	6.61 ± 0.06
AIO for 3 h	$5.67 \pm 0.24^{***}$	$5.95 \pm 0.12^*$	$5.85 \pm 0.15^{***}$
Series I	6.38 ± 0.13	$6.21 \pm 0.12^*$	$6.21 \pm 0.07^*$
Series II	$6.27 \pm 0.06^*$	6.38 ± 0.13	$6.27 \pm 0.16^*$
Series III	6.31 ± 0.31	6.48 ± 0.27	6.25 ± 0.06

Legend: * $p < 0.05$ for difference from control;
 ** $p < 0.05$ for difference from data obtained in experiments 20 h after relief of AIO after 3 h, without UV irradiation.

irradiation. After intracorporeal photomodification of the blood contractility was restored to 85.4% ($p > 0.05$). The sensitivity of SMC to acetylcholine after relief of AIO was 96.5% without irradiation, 94.9% ($p < 0.05$) with UV irradiation of the ileum, and 95.5% with intracorporeal photomodification of the blood.

Strangulated Segment. After relief of AIO without irradiation the force of contraction of SMC and their sensitivity to acetylcholine were 88.9% ($p > 0.05$) and 93.9% ($p < 0.01$) respectively. Contractile activity with UV irradiation of the ileum after relief of AIO was 52.8%, lower than values obtained without irradiation ($p < 0.05$). When relief of AIO was followed by intravascular UV irradiation of the blood, contractility of SMC was 63.2%. The sensitivity of SMC to acetylcholine in the case of external irradiation after relief of AIO was 96.5%, whereas after intracorporeal photomodification of the blood it was 98.0%. These values did not differ statistically significantly from the control. Thus in the strangulated segment of the intestine in AIO the sensitivity of SMC to acetylcholine was significantly reduced, but later it recovered after UV irradiation of the intestine and after intracorporeal UV irradiation of the blood.

Efferent Segment. After relief of AIO the sensitivity of SMC to acetylcholine was increased to 93.9% ($p < 0.001$). Unlike sensitivity, the force of contractions rose significantly, and exceeded values in the control group by 20.3%. Under the influence of UV irradiation the sensitivity of SMC to acetylcholine after relief of AIO did not differ significantly from the data in experiments without irradiation. ED_{50} after UV irradiation of the ileum was 94.9% ($p < 0.05$) of the control level, whereas after UV photomodification of the blood it was 94.6% ($p < 0.001$). Contractility of SMC, in the case of UV irradiation of the ileum after relief of AIO was 84%, which differs from the values obtained without irradiation ($p < 0.05$); after intracorporeal modification of the blood it was 63.2%, which differs from the control ($p < 0.05$) and also from the results obtained without irradiation ($p < 0.001$).

The results are evidence that sensitivity of SMC to acetylcholine in AIO is more resistant to the action of damaging factors than structures of the contractile apparatus of SMC. Under our experimental conditions UV laser irradiation does not facilitate restoration of activity of intestinal SMC in AIO. The positive effect of UV laser irradiation of the ileum and intracorporeal photomodification of the blood on recovery of sensitivity of SMC to acetylcholine in the strangulated segment of the intestine encourages the hope of more rapid correction of motor disturbances in the late stages after relief of AIO and is evidence that the mechanism of this effect is systemic, and evidently connected with the blood.

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