EFFECT OF PNEUMOPERITONEUM AND OXYGENOPERITONEUM ON THE ACTIVITY OF THE KIDNEYS

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The injection of air or oxygen into the peritoneum is widely used at the present time for therapeutic [4] and diagnostic [2, 3] purposes. However, the effect of this procedure on the various organs and systems has not received adequate experimental investigation. In particular, there are no references in the literature to changes in the activity of the kidneys after intraperitoneal injection of oxygen and air. The present experimental investigation was carried out to remedy this omission.

EXPERIMENTAL METHOD

The effect of pneumoperitoneum and injection of oxygen into the peritoneum (oxygenoperitoneum) was studied in chronic experiments on mice, rats, and dogs against the background of spontaneous and water-induced diuresis. The effect on the spontaneous diuresis was studied in experiment on rats and dogs. Throughout the period of investigation the rats were kept in metabolic cages on a constant diet and water intake, and the volume of water which they drank was recorded daily. After every 3-4 control days the animals received an intraperitoneal injection of oxygen or air in a volume of 6 ml/100 g body weight at the same time of day. In a preliminary operation on the dogs the ureters were exteriorized onto the anterior abdominal wall by the Pavlov–Tsitovich method. On the days of the experiments the animals were kept on a Pavlov bench and the urine was collected every 15 or 30 min for 5-6 h. After the background level of excretion of urine had been established oxygen was injected intraperitoneally into the dogs over a period of 1 h from a Bobkov's apparatus in a volume of 35 or 60 ml/kg body weight.

The water diuresis experiments were carried out on mice and rats by the following method. For 3 h before the experiments began the animals were deprived of water, and thereafter water was given through a gastric tube at the rate of 5% of the body weight. On the days of the experiments, immediately after the water load oxygen or air was injected intraperitoneally (for the mice 4 ml, for the rats 6 ml/100 g body weight per animal). The animals were then kept in metabolic cages (the rats individually, the mice 4 at a time) and the urine was collected during 3 successive hours of observation. Water diuresis was induced in the dogs by administration of water at the rate of 5% of the body weight by gastric tube, and immediately after this procedure oxygen was injected as described above.

In all the experiments records were kept of the diuresis, the excretion of sodium and potassium (by flame photometry), and in the experiments with spontaneous diuresis, in addition, the filtration and reabsorption function of the kidneys. The last-mentioned was determined in relation to endogenous cretinine, the concentration of which in the urine was determined by Folin's method, and in the blood by E. B. Berkhin's modification of Folin's method [1].

EXPERIMENTAL RESULTS

Changes in spontaneous diuresis were studied in experiments using four rats in which records were kept of the 24-hourly excretion of urine, sodium, potassium, and creatinine. As Fig. 1 shows, in this case pneumo- and oxygenoperitoneum caused oliguria, with retention of sodium in the body and with insignificant changes in the potassium excretion. The Na/K ratio of the urine showed a significant decrease. Comparison of the level of excretion of creatinine (which passes through the renal glomerular filter and is not thereafter reabsorbed by the tubular epithelium, so that it serves as a measure of filtration) showed that the observed changes in diuresis were due mainly to an increase in tubular reabsorption. The volume

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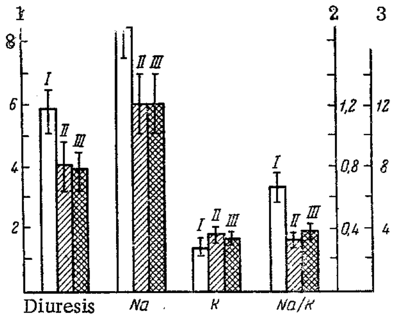

Fig. 1. Effect of intraperitoneal injection of oxygen and air on spontaneous diuresis and excretion of sodium and potassium in rats. Vertical axes: 1) diuresis (in ml/day); 2) excretion of sodium and potassium (in meq/day); 3) Na/K ratio; I) control; II) experiments with injection of air; III) experiments with injection of oxygen.

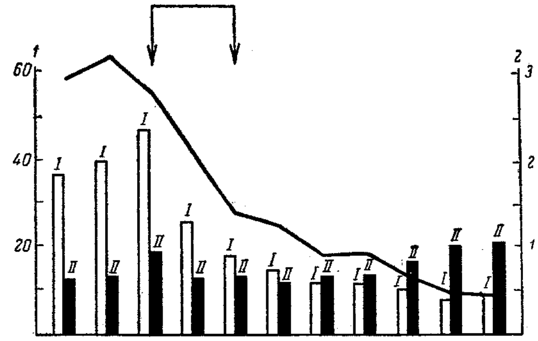

Fig. 2. Effect of intraperitoneal injection of oxygen on excretion of sodium and potassium during spontaneous diuresis (experiment on the dog Biya on 4/7/1964). Vertical axes: 1) excretion of sodium and potassium (in μeq/min); 2) Na/K ratio. Horizontal axis: time marker (15 min). I) Excretion of sodium; II) potassium. Continuous line – Na/K ratio. The arrows point to the beginning and end of injection of 1 liter of gas.

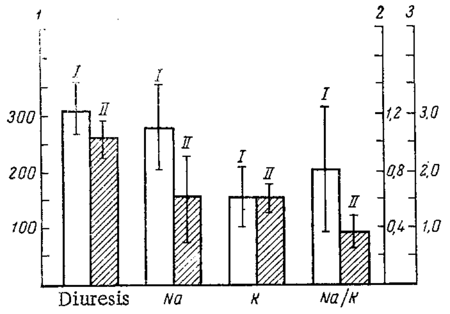

Fig. 3. Effect of intraperitoneal injection of oxygen on the water diure- and the excretion of sodium and potassium (experiment on the dog Éta). Vertical axes: 1) diuresis (in ml/3 h); 2) excretion of sodium and potassium (in meq/3 h); 3) Na/K ratio; I) control (mean of 5 investigations); II) experiments with injection of oxygen (mean of 5 investigations).

fluid drunk was not significantly changed. In the experiments on dogs (14 experiments on 3 animals), during the injection of gas into the peritoneal cavity the diuresis did not change significantly, but later if fell gradually, and these changes were not accompanied by any marked changes in filtration. However, the control experiments yielded similar results. More significant changes were observed in the excretion of electrolytes (Fig. 2). The excretion of sodium fell rapidly in the course of the experiment and after 4-5 h it was sharply depressed. Meanwhile the excretion of potassium either remained unchanged during this period or it was increased. The opposite direction of the changes in the excretion of these cations is illustrated by the curve of the Na/K ratio. In the control experiments no such changes were observed. Hence, in the experiments on dogs also, characteristic changes were found in the excretion of electrolytes.

The effect of pneumo- and oxygenoperitoneum on the water diuresis was studied in experiments on 24 mice and 7 rats. The results obtained are shown in Tables 1 and 2, from which it is clear that the injection of oxygen and air produced a statistically significant decrease in the diuresis and the sodium excretion, which was approximately the same in the mice and rats, whereas the excretion of potassium remained practically unchanged and, in some cases, actually rose. As in the spontaneous diuresis experiments a decrease in the Na/K ratio was observed. Similar changes were noted in 25 experiments on 3 dogs (Fig. 3).

The analysis of the results of the observations on the action of pneumo- and oxygenoperitoneum on the water and spontaneous diuresis in experiments on different animals showed, first, that oxygen and air had approximately the same effect on the renal function. This is evidence that the effect is nonspecific, and is evidently related to the increased intraperitoneal pressure, more especially because similar changes affecting the kidneys were obtained by Bradley and co-workers [5] in human subjects with pneumatic cuffs applied to the abdomen. The results concerning the excretion of sodium and potassium and the constantly

TABLE 1. Effect of Intraperitoneal Injection of Oxygen and Air on Water Diuresis in Mice

Substance injected	Diuresis (in ml/3 h)			Na (in μeq/3 h)			K (in μ eq/3 h)			Na/K ratio	
	n	$M \pm m$	P	n	$M \pm m$	P	n	$M \pm m$	P	$M \pm m$	P
Control	50	2,9±0,1		29	157,6±16,4		29	66,7±3,8		3,2±0,7	
Air	47	2,0±0,1	<0,001	30	120,2±10,1	<0,05	30	68,2±5,5	>0,2	1,9±0,2	<0,05
Oxygen	49	2,0±0,1	<0,001	28	120,4±11,2	<0,05	28	72,8±5,6	>0,5	1,3±0,2	<0,05

TABLE 2. Effect of Intraperitoneal Injection of Oxygen and Air on Water Diuresis in Rats

Substance injected	n	Diuresis (in ml/3 h)		Na (in μeq/3 h)		K (in μeq/3 h		Na/K ratio	
		$M \pm m$	P	$M \pm m$	P	$M \pm m$	P	$M \pm m$	P
Control	56	7,3±0,2		101,5±6,4		78,6±4,7		1,4±0,08	
Air	28	5,8±0,2	<0,001	51,6±4,6	<0,001	71,9±5,6	>0,5	0,8±0,08	<0,001
Oxygen	28	5,9±0,2	<0,001	51,7±3,5	<0,001	69,8±4,7	>0,5	0,8±0,04	<0,001

observed fall in the Na/K ratio, which many authors [9, 10] consider to be an index of the aldosterone secretion, suggest a possible increase in the amount of mineralocorticoids entering the blood stream following this procedure.

According to reports in the literature [8], an increase in intraperitoneal pressure in dogs causes a rise of venous pressure and a fall in the circulating plasma volume. It has also been shown that venous stasis, on the one hand, and a decrease in the circulating plasma volume, on the other, stimulate the secretion of aldosterone [6, 7].

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