CHANGES IN RENAL FUNCTION AND IN THE SODIUM AND POTASSIUM CONCENTRATIONS IN THE SERUM AND URINE IN COLITOXICOSIS

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Intravenous injection of colitoxin into dogs depressed the concentration and clearance functions of the kidneys and reduced the sodium ion concentration in the urine. The potassium ion concentration in the urine was increased.

Gastro-intestinal diseases in man are frequently caused by enteropathogenic strains of Escherichia coli. In these conditions (and especially in children), a generalized toxicosis frequently develops.

Changes in the circulation and disturbances of the clotting system of the blood in experimental colitoxicosis have been described in the literature [7-9]. In animals poisoned with colitoxin, the function of external respiration and the nervous regulation of respiration also are disturbed [1]. The toxin of E. coli depresses tissue respiration of the liver and reduces the activity of the liver cholinesterase and blood serum [4, 5].

The object of the investigation described below was to study the effect of toxin of E. coli on the concentration and clearance functions of the kidneys in dogs, and at the same time to study the concentrations of sodium and potassium ions in the blood serum and urine.

Experimental animals consisted of 43 female dogs weighing 8-12 kg, 23 of which received injections of colitoxin; the other 20 acted as the control.

A filtrate of a broth culture of E. coli (strain No. 026) was injected intravenously into the experimental dogs in a dose of 1.5-2.0 ml/kg.

Two series of experiments were carried out on unanesthetized dogs. In the animals of series I the concentration and clearance functions of the kidneys relative to sodium thiosulfate were determined by an iodometric method. In the dogs of series II, changes in the sodium and potassium ion concentrations in the blood serum and urine were investigated by flame photometry on the PPF UNIIZ apparatus.

The experiments were carried out on fasting animals. Urine for investigation was taken from the bladder through a sterile catheter, and blood samples were taken from the marginal vein of the ear. In all experiments the blood and urine samples were taken for testing before injection and 30, 60, and 90 min and 2, 3, 5, 6, 24, and 48 h after injection of the toxin.

EXPERIMENTAL RESULTS

The dogs developed dyspnea, hypersalivation, vomiting, tachycardia, and frequently, generalized adynamia 60-90 min and, in some experiments, 30 min after intravenous injection of the colitoxin. Observations showed that 30 min after injection of colitoxin the concentration and clearance indices of the kidneys were reduced (Table 1). The decrease in concentration and clearance functions of the kidneys reached a maximum 3-4 h after injection of the toxin and continued for 4 h. Later (6, 24, and 48 h after injection of

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TABLE 1. Changes in Concentration Index and Clearance Index in Dogs with Colitoxicosis (M ± m)

Group of animals	No. of expts.	Concentration index	Minute diuresis (in ml)	Clearance index (clearance/ml/min)
Control	10	86,6±3,2	0,98±0,06	84,6±4,0
After injection of colitoxin				
30 min	10	63,2±4,6 P<0,001	1,02±0,12 P>0,5	67,2±6,3 P<0,5
60 "	10	57,8±3,9 P<0,001	1,02±0,06 P>0,5	61,8±5,3 P<0,02
90 "	10	54,6±2,5 P<0,001	0,97±0,06 P>0,5	55,3±4,1 P<0,001
120 "	10	47,0±3,3 P<0,001	1,04±0,06 P>0,5	48,7±3,3 P<0,001
3 h	10	44,4±3,0 P<0,001	1,03±0,08 P>0,5	44,1±2,3 P<0,001
4 h	10	44,2±2,1 P<0,001	1,2±0,46 P>0,5	47,8±4,4 P<0,001
5 h	10	46,5±3,4 P<0,001	1,09±0,11 P>0,5	49,0±4,9 P<0,001
6 h	10	54,4±4,3 P<0,001	0,93±0,09 P>0,5	50,1±4,5 P<0,001
24 h	10	61,8±3,8 P<0,001	0,80±0,08 P>0,2	53,2±6,1 P<0,001
48 h	10	60,6±2,7 P<0,001	0,85±0,02 P>0,5	53,4±5,0 P<0,001

TABLE 2. Changes in Sodium and Potassium Ion Concentrations in Urine and Serum of Dogs with Colitoxicosis (M ± m)

Group of animals	No. of expts.	Blood serum		Urine	
		sodium ion concn. (in mg %)	potassium ion concn (in mg %)	sodium ion concn. (in mg %)	potassium ion concn. (in mg %)
Control	13	265,8±6,2	19,6±1,3	259,7±7,9	220,0±8,1
After injection of colitoxin					
30 min	13	263,0±8,0 P>0,5	17,7±2,2 P>0,5	222,0±2,2 P<0,001	244,1±4,8 P<0,02
60 "	13	264,0±6,1 P>0,5	17,8±1,4 P>0,5	212,8±8,0 P<0,001	274,0±8,4 P<0,001
90 "	13	261,1±7,6 P>0,5	18,0±1,9 P>0,5	169,8±10,9 P<0,001	302,6±9,1 P<0,001
2 h	13	263,3±6,8 P>0,5	17,7±1,5 P>0,5	156,3±2,9 P<0,001	316,8±10,2 P<0,001
3 h	13	241,8±7,5 P<0,02	18,0±1,6 P>0,5	144,8±6,1 P<0,001	314,6±12,1 P<0,001
4 h	13	216,4±1,1 P<0,001	17,8±1,2 P<0,5	152,0±8,0 P<0,001	299,9±9,1 P<0,001
5 h	13	198,6±9,9 P<0,001	18,2±1,2 P>0,5	159,3±1,4 P<0,001	298,2±7,8 P<0,001
6 h	11	189,4±9,9 P<0,001	18,9±1,7 P>0,5	166,9±11,6 P<0,001	293,9±11,6 P<0,001
24 h	11	238,3±5,8 P<0,001	19,0±2,0 P>0,5	208,6±9,5 P<0,001	275,4±8,1 P<0,001
48 h	11	237,1±5,4 P<0,01	19,1±2,3 P>0,5	211,5±7,5 P<0,001	249,4±7,8 P<0,05

the colitoxin), the concentration and clearance functions of the kidneys began to improve although, however, they still remained significantly depressed ($P < 0.001$) by comparison with their initial level.

The study of the ionic composition of the serum and urine gave the following results. The sodium ion concentration in the urine was significantly reduced 30 min after injection of the toxin, while the potassium ion concentration was increased (Table 2). These changes in the ionic composition of the urine were observed for 3 h. The decrease in sodium ion concentration in the urine and the increase in potassium ion concentration reached a maximum 3 h after injection of the colitoxin. At the subsequent times of observation the sodium ion concentration in the urine rose slightly while the potassium ion concentration fell, although they still remained significantly ($P < 0.001$) below and above their initial levels, respectively.

The decrease in the sodium ion concentration in the urine and the increase in its potassium ion concentration were evidently due to increased liberation of aldosterone into the blood stream, increasing the reabsorption of sodium and leading to an increase in the sodium permeability of the cell membranes.

The sodium ion concentration in the serum was unchanged for 2 h after injection of the toxin, but thereafter it began to fall (Table 2). The decrease was greatest 5-6 h after injection of the colitoxin ($P < 0.001$). The sodium concentration in the blood serum also was below the control level after 24 and 48 h. The potassium ion concentration in the blood serum was close to the control value at all times during the experiment (19.1±2.3 mg%).

It can be concluded from these experiments that in toxicosis due to enteropathogenic strains of E. coli the concentration and clearance functions of the kidneys are depressed, and the electrolyte balance is appreciably disturbed. It is considered that these disturbances are due to changes in the activity of the hypothalamo–hypophyseo–adrenal system which regulates the liberation of vasopressin and aldosterone into the blood stream [2, 3, 6].

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