INTEROCEPTIVE SYSTEM OF THE LEFT ATRIUM AND ITS ROLE IN OSMOREGULATION

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Stimulation of the interoceptive field of the left atrium in experiments on dogs by hypertonic solutions gave a well-defined antidiuretic effect accompanied by a marked increase in sodium excretion.

Considerable experimental evidence has been collected as the result of recent work in the physiology of water and mineral metabolism to show the participation of receptors of the left atrium in the regulation of the blood volume [4–7].

The object of the present investigation was to examine the role of this receptor zone in maintenance of the constancy of the osmotic concentration of the body fluids.

EXPERIMENTAL METHOD

Acute and chronic experiments were carried out on adult dogs.

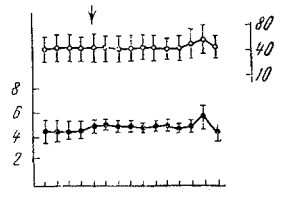

Fig. 1. Effect of injection of 3% NaCl solution into left atrium of hypophysectomized dogs on sodium excretion and diuresis. Abscissa, time (5-min intervals); ordinate: left – diuresis (in ml · min^{-1} · m^{-2}), right – sodium excretion (in μeq · min^{-1} · m^{-2}). Vertical lines show confidence limits (P = 0.05).

In the chronic experiments changes in diuresis and sodium excretion were studied during osmotic stimulation of the left atrium by hypertonic sodium chloride solutions and by glucose solutions of the following composition isoosmotic with them: 1) 1.5–3% NaCl, 0.42% KCl, 0.24% $CaCl_2$, 0.15% $NaHCO_3$; 2) 8.6–18.3% $C_6H_{12}O_6$, 0.42% KCl, 0.24% $CaCl_2$, 0.15% $NaHCO_3$.

Preliminary operation on the animals included the formation of a gastric fistula, exteriorization of the ureters by the Pavlov–Orbeli method, and implantation of a polyethylene catheter into the left atrium. During the experiment a constant level of hydration of the animal was maintained by frequent administration of small doses of water into the stomach. On the attainment of a uniform background level of diuresis, the test solutions, warmed to 38°C, were injected into the left atrium in a volume of 5 ml in 30 sec. The diuresis was measured every 5 min. The sodium concentration was determined by flame photometry and its absolute content (UV) was expressed in microequivalents per minute per square meter (μeq · min^{-1} · m^{-2}). The renal filtration was determined relative to endogenous creatinine by the method of Tareev and Ratner. Some experiments were carried out on hypophysectomized animals.

In the acute experiments, the localization of stimulation was studied by measuring changes in the sodium concentration in the blood in the left atrium, left ventricle, and ascending aorta. These experiments were carried out as follows. Under chloralose anesthesia a catheter was tied into the left auricle

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TABLE 1. Changes in Diuresis and Sodium Excretion after Injection of Hypertonic NaCl and Glucose Solutions of Different Concentrations (M ± m)

Stimulus	Concentration (in %)	Change in diuresis		
		reproducibility of response (in %)	degree of decrease in in diuresis (in % of initial level)	duration (in min)
NaCl	10,9	0	0	0
	1,5	100	45,19±1,25	67,70±6,35
	3,0	100	46,22±2,62	71,12±8,30
Glucose	8,6	73,7	34,87±5,30	50,30±6,07
	18,3	100	42,86±4,09	60,00±5,18

Table 1. (Continued)

Stimulus	Change in sodium excretion				
	Reproducibility of response	background sodium excretion	maximal sodium excretion during response	increase in sodium excretion	Duration (in min)
		$\mu eq \cdot min^{-1} \cdot min^{-2}$			
NaCl	0	0	0	0	0
	94,12	89,76±3,13	127,76±3,07	38,00±3,89	55,00±5,53
	88,24	52,06±2,71	115,31±3,18	63,25±5,02	41,94±4,68
Glucose	92,86	147,05±3,45	187,31±3,26	40,26±4,84	43,57±7,05
	100	60,00±2,32	120,50±3,50	60,54±4,47	61,71±4,40

TABLE 2. Changes in Sodium Concentration in Blood Plasma from the Left Atrium, Left Ventricle, and Ascending Aorta following Injection of 3% NaCl Solution into Left Atrium (M ± m)

	Blood sodium concentration (in meq/liter)		
	control	during period of injection	change in concentration
Left Atrium	151,13±2,45	168,62±2,57	+17,49±2,90
Left Ventricle	155,12±2,30	157,07±3,51	+1,95±0,99
Ascending aorta	151,28±3,22	150,17±3,30	−1,11±0,67

and 3% NaCl solutions injected through it. Blood from these regions was collected by a syringe before and after injection of the stimulus. The sodium concentration was determined in the resulting samples of plasma.

EXPERIMENTAL RESULTS

Since the zone investigated contains volume receptors responding to changes in blood volume, the first essential was to exclude volume effects of the injected hypertonic solutions. For this purpose 17 experiments were carried out on 4 dogs in which Ringer's solution iso-osmotic with blood plasma was injected. The results in Table 1 show that injection of physiological saline had no effect on the volume receptors of the left atrium.

A different effect was observed after injection of hypertonic 1.5-3% NaCl solutions (35 experiments on 7 dogs) and of 8.6-18.3% glucose solutions iso-osmotic with them (33 experiments on 10 dogs). A distinct decrease in diuresis, accompanied by increased sodium excretion was observed (Table 1).

The experiments to determine changes in the sodium concentration directly in the blood of the left atrium, left ventricle, and ascending aorta (34 experiments on 9 dogs) showed (Table 2) that the ionic changes observed in the left atrium were absent in blood from the left ventricle and aorta. This suggests

that the renal response is reflex in nature and takes place through excitation of the osmoreceptors located in the wall of the left atrium.

The experiments to study the creatinine clearance (18 experiments on 4 intact dogs) showed that the inhibition of water and sodium excretion during osmotic stimulation of the left atrium was due principally to an increase in the reabsorption of water, on the average by 3.45% ($P < 0.02$), and to some inhibition of sodium reabsorption (on the average by 0.97%).

This finding suggested that the changes in renal function in these experiments took place on account of a change in the secretion of neurohypophyseal hormones (vasopressin and oxytocin), a highly characteristic feature of osmoregulatory reflexes from the liver, spleen, lungs, and other osmoreceptive zones [1–3].

This hypothesis was confirmed by experiments on hypophysectomized animals (8 chronic experiments on 2 dogs). In none of the experiments did injections of hypertonic NaCl solutions into the left atrium give rise to the development of an antidiuretic response or depress the sodium excretion (Fig. 1).

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