Water and Salt Consumption and Suppression of Angiotensin-Induced Thirst in Rats after Carotid Glomectomy

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Carotid glomectomy in rats reduced daily water consumption and increased daily consumption of NaCl solution. Sham operation did not modify water and salt consumption. Intraperitoneal injection of angiotensin-II did not stimulate drinking motivation in the majority of rats subjected to carotid glomectomy. Injection of angiotensin-II to sham-operated and intact animals induced active consumption of both fluids during one hour. These results attest to the involvement of the carotid body in the regulation of consumption of water and sodium ions (the main elements of osmotic blood pressure) and the involvement of angiotensin-sensitive receptors of carotid body cells in the formation of thirst and salt appetite motivation, regulated by the renin-angiotensin system.

Key Words: *water-salt balance; carotid body chemoreceptors; carotid glomectomy; renin-angiotensin system; angiotensin-II*

Autoregulation of homeostatic parameters of the water-salt metabolism is mediated by central and peripheral mechanisms of thirst regulation. The renin-angiotensin system plays an important role in the realization of thirst [4,9,12,15]. The involvement of angiotensin-sensitive receptors of peripheral blood vessels in the mechanisms of thirst development is virtually not studied. The carotid body (CB) is an important vascular chemoreceptor system involved into the mechanisms of autoregulation of many homeostatic constants [1,2,5,6,11], including components of the water-salt metabolism. This is indirectly confirmed by the facts that sensory cells of CB react to osmotic parameters of the blood [8] and have receptor structures sensitive to angiotensin-II (A-II) [7,10,13,14]. However, direct evidence on the involvement of the CB chemoreceptor system into the regulation of thirst and salt appetite is scanty. We studied the possible role of CB chemoreceptors in the regulation of water and salt consumption and in the formation of A-II-induced thirst.

MATERIALS AND METHODS

Experiments were carried out on 17 male Wistar rats with the initial weight of 265.0±13.8 g. The animals received standard granulated fodder *ad libitum* throughout the experiment.

The animals were kept in individual standard boxes with two burettes (with water and 1% NaCl solution) for 4 weeks; the volume of consumed fluid was daily measured. The positions of burettes with the fluids were daily alternated. After the first 2 weeks the experimental rats (n=6) were subjected to bilateral carotid glomectomy (CGLE) [3] under ether narcosis, controls (n=6) were sham-operated.

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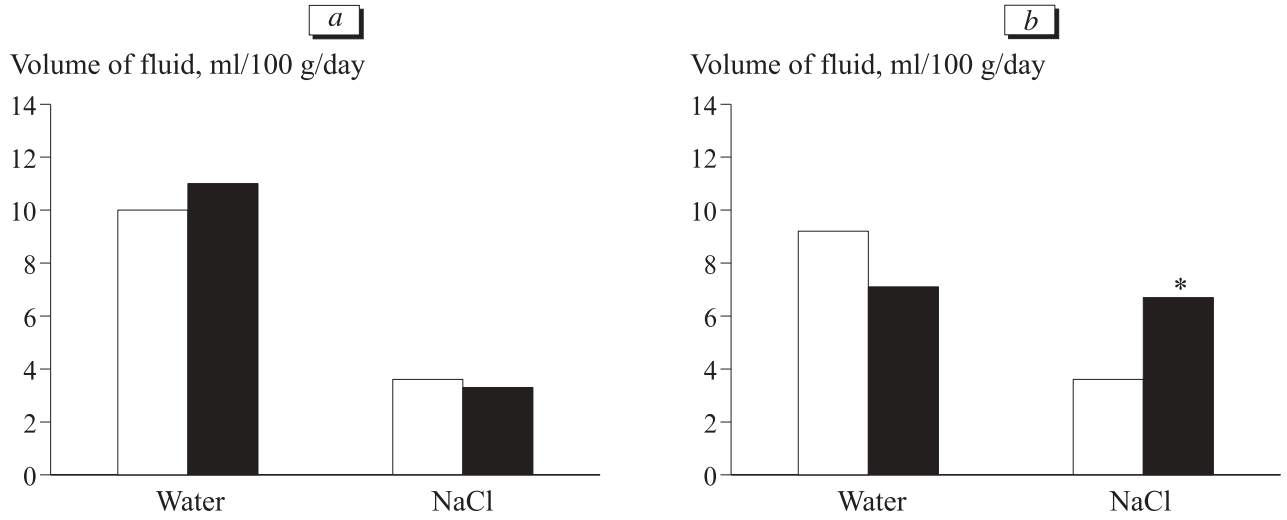

Fig. 1. Effect of carotid glomectomy on water and NaCl consumption. *a*) control (sham operation); *b*) experiment (carotid glomectomy). Light bars: before; dark bars: after the operation. *$p<0.01$ compared to the corresponding parameter before surgery.

Then experimental and control rats were intraperitoneally injected with normal saline (1 ml) and their behavior was observed for 1 h. After 3 days the animals were intraperitoneally injected with A-II (Sigma; 300 μg/kg in 1 ml saline) and the volumes of water and saline drunk over 1 h postinjection were measured. Intact animals (n=5) received the same injection for controlling drug efficiency.

The significance of the results was evaluated by Wilcoxon tests for bound and free variables.

RESULTS

The volumes of consumed fluids changed in animals after CGLE. The mean daily water comsumption was lower and that of NaCl solution significantly ($p<0.01$) higher in experimental rats in comparison with the corresponding parameters before surgery (Fig. 1). It is noteworthy that the total volumes of daily fluid consumption (water+saline) were virtually the same before and after CGLE. In control rats daily volumes of consumed water and saline and the total volumes of consumed fluids were virtually the same before and after sham operation. Both experimental and control animals preferred water to saline before the intervention. After the intervention experimental rats consumed virtually the same volumes of fluids, while controls still preferred water (Fig. 1).

The dipsogenic effect of A-II was suppressed in rats after CGLE. Only one of 6 rats drank water and saline during the first hour after injection of A-II, while other 5 rats exhibited no signs of thirst and did not approach the drinking bowls ($p<0.001$; Fig. 2). The typical effect of A-II (active drinking after previous consumption of sufficient volume of water) manifested in all control sham-operated (Fig. 2) and intact animals. Injection of normal saline to experimental and control animals had not effect on their behavior.

Together with activity of CB chemoreceptors reacting to changes in blood oxygen, carbon monoxide, and pH [1,2,5,6,11], activity of CB cells during modification of blood osmolarity [8] seems to be an important component in the systemic regulation of balance of fluids and their mineral composition in the body. We showed that CB is an important chemoreceptor system involved in the maintenance of the balance of water and Na ions (main factors determining the osmotic pressure of the blood). CGLE led to more intense consumption of NaCl solution and a decrease of water consumption under conditions of unlimited offer of both fluids.

A-II, the main effector peptide of the renin-angiotensin system, initiated thirst and consumption of

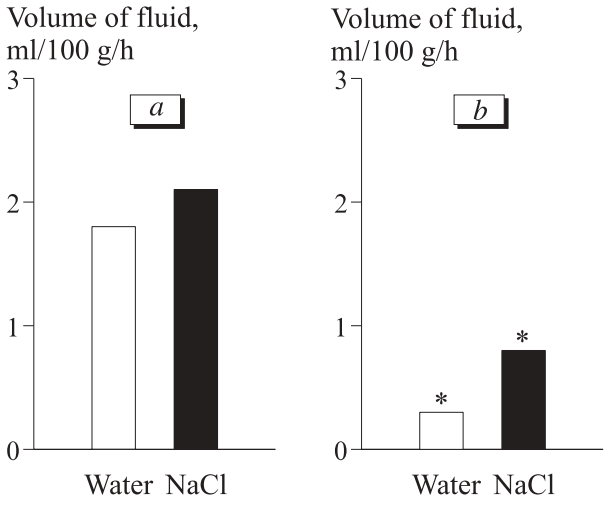

Fig. 2. Suppression of the dipsogenic effect of angiotensin-II in rats after carotid glomectomy. *a*) control; *b*) carotid glomectomy. *$p<0.01$ compared to the control.

NaCl solution after systemic and intracerebral injection [4,9,12,15]. The presence of A-II receptors in CB cells [10,13,14] and the stimulatory effect of A-II on the afferent pulsed activity of the sinocarotid nerve during CB perfusion in rats [7] suggest the involvement of carotid A-II-sensitive receptors in the central and peripheral mechanisms of water-salt balance regulation with the participation of the renin-angiotensin system. Blocking of the dipsogenic effect after systemic injection of A-II to rats subjected to CGLE points to CB as a peripheral target of this peptide circulating in the blood. Comparative analysis of the effects of systemic and intracerebral injections of A-II on thirst motivation in glomectomied rats is required for better understanding of the role of CB A-II-sensitive receptors in the mechanisms of A-II-induced water and saline consumption.

Hence, along with the central structures, CB is involved in the regulation of thirst as the peripheral A-II-sensitive chemoreceptor system.

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