

EFFECT OF ADRENALECTOMY ON SUCCINATE DEHYDROGENASE ACTIVITY AND SODIUM REABSORPTION IN THE RENAL TUBULES

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The reabsorption of sodium in the renal tubules is regulated by the hormones of the adrenal cortex with mineralocorticoid activity, aldosterone and desoxycorticosterone (DOCA) [4-6]. However, the intimate mechanism of action of these hormones on the epithelium of the renal tubules has received little study.

In experiments on rats, Yu. V. Natochin and co-workers [2] showed that adrenalectomy is accompanied by a decrease in the succinate dehydrogenase activity of the renal tubules. This decrease is particularly marked in the distal portions of the nephron where sodium reabsorption regulated by the mineralocorticoids takes place. Administration of DOCA to adrenalectomized rats restored the succinate dehydrogenase activity.

The evolutionary aspect of the osmoregulatory organs of the vertebrates was studied by Yu. V. Natochin and T. V. Krestinskaya [3], who demonstrated high succinate dehydrogenase activity in the sodium transporting organs. It was concluded from their results that the connection between the activity of this enzyme and sodium reabsorption is so close that the distribution of succinate dehydrogenase may be used to demonstrate places of active sodium transportation [1].

The very few investigations of this type and the absence of reports comparing histochemical data with the functional state of the kidneys led the authors to study the activity of the enzyme in the kidneys of dogs after adrenalectomy and during the subsequent administration of DOCA, investigating the intensity of sodium reabsorption in the renal tubules.

EXPERIMENTAL METHOD

Experiments were carried out on dogs anesthetized with hexobarbital, and to maintain the diuresis at a constant level, the animals received 0.9% sodium chloride solution (2.5-3.0 ml/min) by intravenous injection. The urine was collected every 20 min by means of polyethylene catheters introduced into the ureters. The glomerular filtration was determined from the endogenous creatinine, and the concentrations of sodium and potassium in the urine and blood were determined by means of a flame photometer; the filtration and reabsorption of sodium were calculated.

After the conclusion of the experiment, the kidneys were investigated histochemically for their succinate dehydrogenase activity by the method of Nachlas and Seligman, using neo-tetrazolium as electron acceptor. Sections were kept in the incubation medium for 30 min at 37°.

Three series of experiments were performed: on control (intact) dogs, on adrenalectomized dogs, and on adrenalectomized dogs receiving a single injection of DOCA intramuscularly or into one of the renal arteries 3-4 h before the histochemical investigation. Bilateral adrenalectomy was carried out 3-5 days before the experiment. In the postoperative period, the animals received 1% sodium chloride solution to drink.

EXPERIMENTAL RESULTS

Succinate dehydrogenase was discovered in the kidneys of the control animals mainly in the distal portion of the nephron, especially in the ascending limbs of the loops of Henle (Fig. 1A), where the largest quantity of precipitated reduced formazan was deposited. In the kidneys of the adrenalectomized animals, a decrease in succinate dehydrogenase activity was clearly seen (Fig. 1B). Formazan precipitates were absent. The mitochondria in the cells were swollen and yellowish in color.

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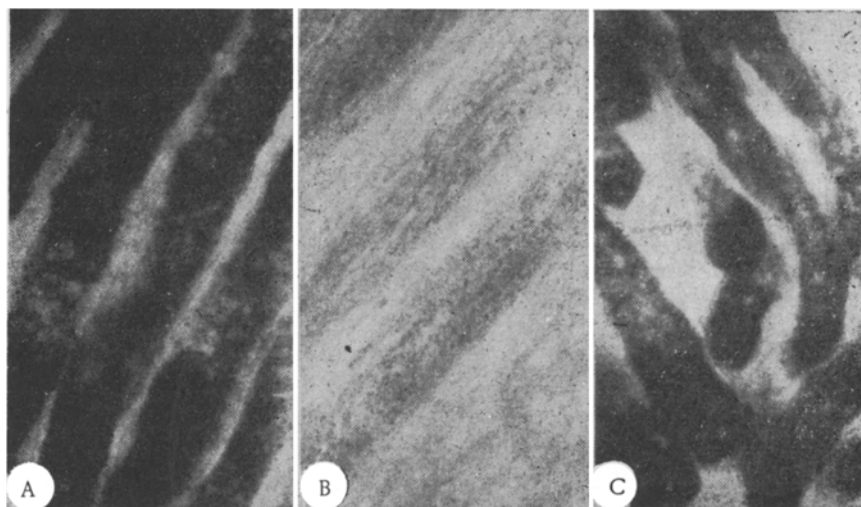


Fig. 1. Succinate dehydrogenase activity in the ascending limbs of the loops of Henle: A) in the normal kidney; B) on the 3rd day after adrenalectomy; C) 4 h after injection of DOCA into an animal undergoing adrenalectomy 3 days before the experiment. Photomicrograph. Objective 8, ocular 10.

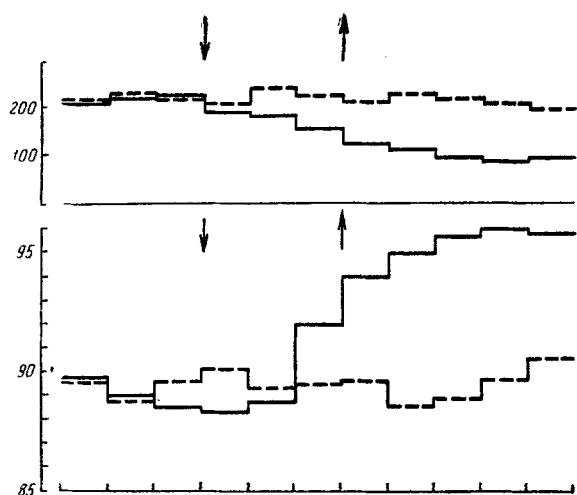


Fig. 2. Effect of DOCA on excretion and tubular reabsorption of sodium after adrenalectomy. Continuous lines — left kidney, broken line — right kidney (control). From top to bottom: sodium excretion (in $\mu\text{eq}/\text{min}$), sodium reabsorption (in % of total filtration charge). Arrows — beginning (\downarrow) and end (\uparrow) of injection of DOCA ($0.05 \text{ mg}/\text{kg}/\text{min}$) into left renal artery. Along the horizontal axis — time marker (20 min).

[2], showing that the succinate dehydrogenase activity is dependent on the activity of the adrenals, and they also demonstrate a definite parallel between the activity of the enzyme activated by DOCA and the reabsorption of sodium in the nephron. On the basis of experiments in which DOCA was injected into one kidney of the adrenalectomized dogs, it was shown that the increase in the activity of the enzyme and the functional changes in the kidneys under the influence of the hormone are mainly the result of its action on the renal tubules, and are not due to extrarenal mechanisms.

Although a definite parallel was detected between the succinate dehydrogenase activity and the sodium reabsorption level, no conclusions can be drawn from these results regarding the character of the link between these phe-

Consistent changes were observed in the activity of the kidneys after adrenalectomy in all the dogs: the Na/K ratio of the urine was increased (from 2.5-4 in the control dogs to 4.3-6.3), the sodium reabsorption was lowered, causing an increase in sodium excretion, and the glomerular filtration was slightly reduced.

Injection of DOCA (2.5-10 mg/kg) into the adrenalectomized animals was accompanied by restoration of the succinate dehydrogenase activity in the distal portions of the nephrons (Fig. 1C). Investigation of the kidney function in these cases showed an increase in the sodium reabsorption and, at the same time, a decrease in the Na/K ratio. The effect of DOCA on the renal function and the activity of the enzyme was most clearly seen when the hormone was injected into one of the renal arteries, in which case the second kidney served as a unique control (Fig. 2).

The results obtained show that the succinate dehydrogenase activity of the nephrons was reduced after adrenalectomy. At the same time, changes were observed in the activity of the kidneys, and in particular, a decrease in the reabsorption of sodium in the renal tubules. The administration of DOCA to the adrenalectomized animals restored the activity of the enzyme and increased the sodium reabsorption. These results confirm the results of experiments carried out by Yu. V. Natochin and co-workers

nomena. The possibility is not ruled out that the changes in succinate dehydrogenase activity and in sodium transportation, although taking place together, are not related to each other as cause and effect. On the other hand, the mechanism responsible for the increase in the activity of the enzyme under the influence of DOCA is not clear. These problems require special investigation.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of the first issue of this year.