

FUNCTIONAL AND MORPHOLOGICAL STATE OF THE ADRENAL COMPLEX

TWO WEEKS AFTER AUTOTRANSPLANTATION

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M. G. Kolpakov, S. G. Kolaeva, E. M. Kazin, and K. T. Titova

Department of Experimental Biology (Head, M. G. Kolpakov),
Institute of Cytology and Genetics (Director, Corresponding Member of the Academy
of Sciences of the USSR D. K. Belyaev), Siberian Branch of the Academy
of Sciences of the USSR, Novosibirsk
(Presented by Academician V. N. Chernigovskii)

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Investigations on rats and rabbits have shown that two weeks after autotransplantation of the adrenals the zona fasciculata and zona reticularis, producing hydroxycorticosteroids, are still in a stage of degeneration, whereas the zona glomerulosa, producing mineralocorticoids, has completely recovered [13, 16, 17]. At this period the blood sugar level is depressed, giving indirect evidence of glucocorticoid insufficiency [13].

In the opinion of some authors, two-week autotransplantation of the adrenals can be used for the selective exclusion of the glucocorticoid function of the gland [8], i.e., for obtaining a unique experimental model for analysis of the separate influence of gluco- and mineralocorticoids in particular processes and states under study [5].

In the present investigation the degree of restoration of the structure and function of autotransplanted adrenals was studied by the usual methods of morphological investigation and also by means of special histochemical methods and physiological tests reflecting various aspects of activity of the glands.

EXPERIMENTAL METHODS

Experiments were carried out on 24 cats. Adrenalectomy was performed by the usual method. The removed glands were transplanted beneath the kidney capsule on the same side and extracted for morphological investigation two weeks later.

To assess the functional state of the autotransplanted adrenals, the ascorbic acid concentration was determined in the adrenal cortex, the glycogen level in the liver, and the potassium concentration in the blood plasma. The ascorbic acid content was calculated by titration with Thielmanns' dye [2]. The glycogen content in the liver was determined by the method described by Asatiani [1]. The potassium level was determined by means of a Zeiss Model III flame photometer [6].

For the histological and histochemical investigation, all the material was fixed in 12% formalin solution and embedded in paraffin wax. For the histological investigation sections were stained with hematoxylin-eosin. For the histochemical determination of proteins the tetrazolium reaction was used [15], revealing amino acids, tyrosine, tryptophan, and histidine; tests for amino groups [20] and for SH- and S-S groups were also carried out [14].

The RNA content in the cytoplasm of the cells of the zona glomerulosa was determined by a microspectrophotometric method described by L. N. Ovchinnikova and G. V. Selivanova [10]. The total lipid content in the cell was determined by the method of Chiffelle and Putt [16], using a solution of Sudan black in ethylene glycol.

EXPERIMENTAL RESULTS

Two weeks after autotransplantation the adrenal cortex was clearly divided into a zone of progressive regeneration and a zone with predominance of degenerative changes. The zone of regeneration consisted entirely of the

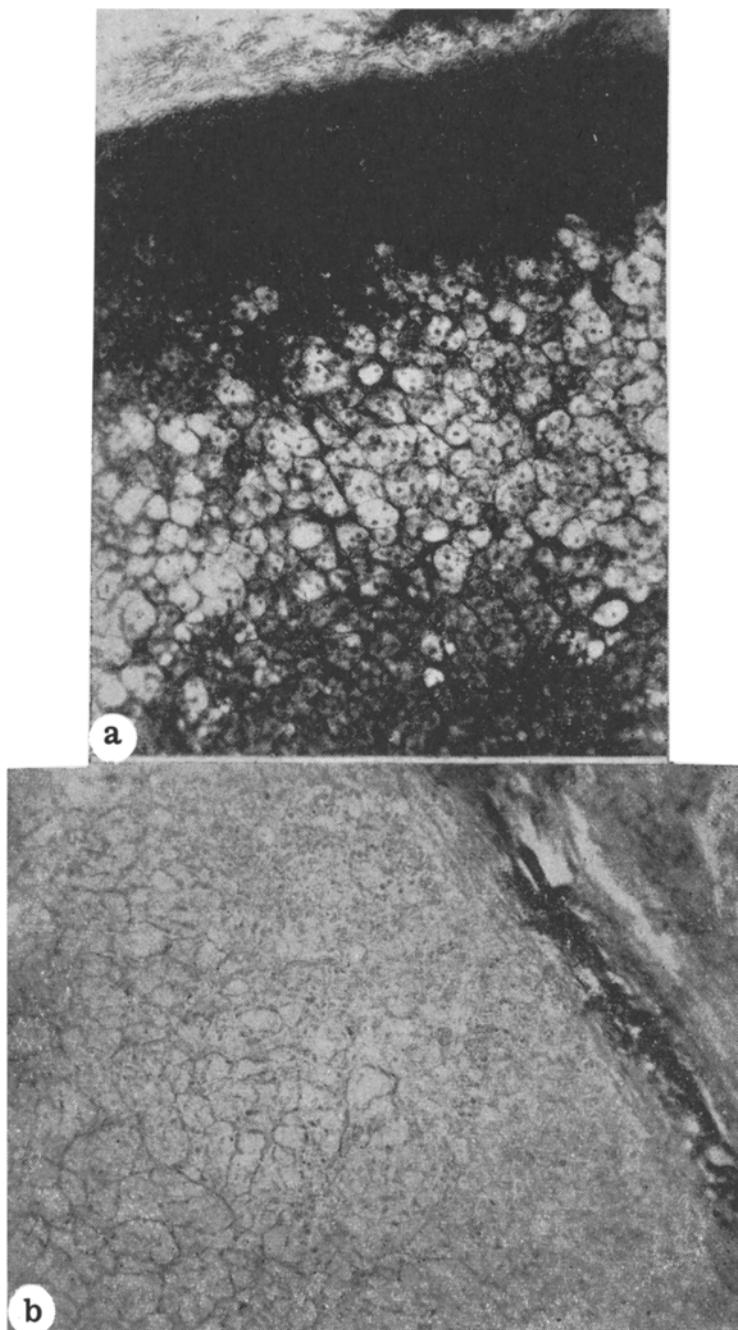


Fig. 1. Reaction of tetrazolium coupling in adrenal cortex. A) Intact gland; the zona glomerulosa is intensively stained; B) two weeks after autotransplantation; feeble staining of zona glomerulosa. Photomicrograph. Objective 20 \times , ocular 7 \times .

zona glomerulosa. In the zona fasciculata and zona reticularis degenerative changes were predominant (necrosis, hemorrhages, infiltration of leukocytes). The preserved cells of the zona fasciculata and zona reticularis were reduced in size and their nuclei were pycnotic.

The intensity of the histochemical reaction for lipids in the cells of the zona fasciculata and the zona reticularis was weak (by comparison with the normal adrenal). All the histochemical tests used to reveal proteins showed a considerable increase in the intensity of staining of the cells of the zona fasciculata and zona reticularis, a characteristic sign of degenerative processes [9, 12].

Changes in Indices of Functional Activity of the Adrenal Cortex
in Cats Two Weeks after Autotransplantation ($M \pm m$)

Adrenals	Ascorbic acid (in mg/100 g)	Glycogen in liver (in mg/100 g)	Potassium in plasma (in meq/ liter)
Intact.....	194.7 \pm 9.1	2540 \pm 389	5.7 \pm 0.3
Autotransplanted.....	44.6 \pm 4.8	1207 \pm 343	10.8 \pm 1.5
P	< 0.001	< 0.01	< 0.01

Structural disorganization of the zona fasciculata and zona reticularis was combined with a considerable fall ($P < 0.001$) in the concentration of ascorbic acid, a substance directly concerned with the biosynthesis of hydroxycorticosteroid hormones, in the adrenal cortex [21]. The low concentration of ascorbic acid in the cortex of the autotransplanted adrenal may be considered not as an index of increased mobilization of the hormones, but as a sign of inadequate production of hydroxycorticosteroids. Indirect evidence of this is also given by the substantial decrease in the glycogen concentration in the liver (see table), the level of which is maintained largely by the glucocorticoid function of the adrenals [3].

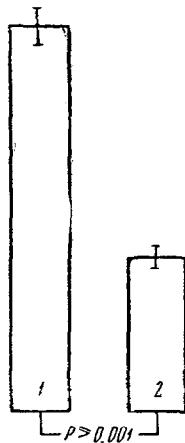


Fig. 2. RNA content in cytoplasm of cells of the zona glomerulosa of the intact adrenal (1) and two weeks after autotransplantation (2).

The zona glomerulosa was intensively hyperplastic, its cells were enlarged and the swollen nuclei were rich in chromatin. The cells of the zona glomerulosa formed separate bands in the subcapsular layer and in the underlying degenerated zone. Two weeks after autotransplantation, the columns of cells still had not regained the form of the specific glomeruli characteristic of the intact adrenal.

Despite the almost complete regeneration of the zona glomerulosa, its mineralocorticoid function was not restored. In the cats two weeks after autotransplantation of the adrenals a very high concentration of potassium was found in the blood (11 meq/liter), reaching the level characteristic of adrenalectomized animals.

The intensity of the histochemical reactions revealing SH- and S-S groups and amino groups in the cells of the zona glomerulosa was higher than normal, evidently in connection with the activation of these groups in the period of tissue regeneration reported in the literature [4]. Meanwhile the content of "total" protein, revealed by the tetrazolium coupling reaction of Danielli (Fig. 1), and the content of lipids were decreased. The fall in the content of "total" protein and the increase, at the same time, in the intensity of the histochemical reactions for amino groups evidently demonstrate the open tertiary structure of the protein and the incompleteness of formation of the protein molecule.

The RNA content in the cytoplasm of the cells of the zona glomerulosa of the cortex in the autotransplanted adrenal was considerably reduced—by 50% compared with normal (Fig. 2). Bearing in mind the role of the ribonucleoprotein granules in the synthesis of corticosteroids [18], it may be suggested that the low RNA content in the cytoplasm of the cells of the zona glomerulosa is one of the pathogenetic mechanisms of insufficiency of mineralocorticoid production.

Hence, in cats two weeks after free autotransplantation of the adrenals beneath the kidney capsule, not only the glucocorticoid but also the mineralocorticoid function of the adrenals has not been restored.

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