Department of Pathological Anatomy (Director: Prof P. ENDES) of the University Medical School, Debrecen, and Department of Anatomy (Director: Prof. J. SZENTÁGOTHAI) of the University Medical School, Pécs

THE GRANULATED CELLS OF THE JUXTAGLOMERULAR APPARATUS IN EXPERIMENTAL LESIONS OF THE HYPOPHYSEAL STALK AND OF THE HYPOTHALAMUS

(A preliminary report)

P. ENDES, I. DÉVÉNYI, B. HALÁSZ and SZ. GOMBA

(Received January 19, 1960)

Of the authors who have studied the granulated cells of the juxtaglomerular apparatus (JGC) pressure of space does not permit us to mention more than a few. GOORMAGHTIGH [1, 2], for example, suggests that these cells originate from the smooth muscle cells of the afferent arterioles and regards the granules in their cytoplasm as the secretion of the cells, a vasopressor substance, probably renin. HARTROFT and HARTROFT [3, 4, 5] found an increase in the granules of the JGC to be accompanied by hypertrophy of the zona glomerulosa, and a degranulation of the JGC to be associated with the atrophy of the said zone; they suggested that this parallelism was really due to changes in the blood sodium level inasmuch as a salt-deficient diet induces hypergranulation and a salt-rich diet degranulation. As regards the correlation between the number of granules in the JGC and other endocrine organs, it has been shown by HARTROFT that hypophysectomy does not significantly affect the degree of granulation. Inducing lesions of the hypophyseal stalk and the tuber cinereum, we studied their effect upon the granulation of the JGC.

Methods

Eighteen rats of the Wistar strain, kept under standard conditions, were used in the experiments. (The cause why we have examined up till now such a small number of animals lies in the lengthiness and laboriousness of the computations.)

Injury of the pituitary stalk and the hypothalamus was placed by means of a Horsley-Clark stereotactic apparatus modified by Szentágothai. Site and extent of the lesions were checked post mortem microscopically.

The rats were divided into 2 groups of 9 animals each. The rats in Series I were sacrificed 9 days, those in Series II 24 days, after inflicting the lesion.

Four sections in the largest horizontal plane of each kidney of each rat, an average of 850 glomeruli per animal, were examined with a magnification of 650. The mean for the four sections was regarded as the index of each individual animal.

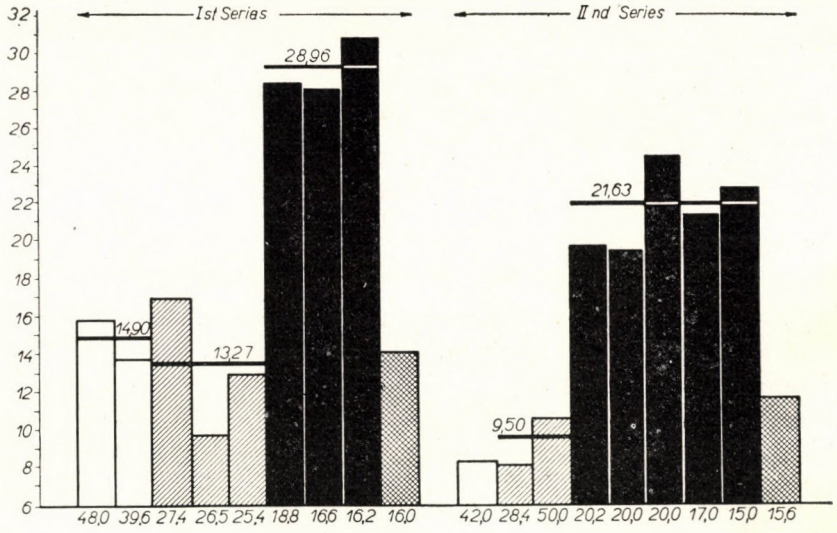
For staining, Endes' trichrome (6) dye was used, by which the granules stain electively a dark violet. Apart from a percentual assessment of the number of granulated cell groups, HARTROFT's method was used with some modifications to estimate the degree of granulation; complexes with a value of 1, 2, 4 resp. 8 were distinguished. The percentual value yielded by this semiquantitative method represented the so-called JGC index.

Results

In Series I, 2 control animals had an average index of 14.90. In 3 animals with partial infundibular lesion the average index was 13.27. In 4 animals the lesion embraced the whole pituitary stalk; at its site a crater had developed. Three of these animals displayed a high index, averaging 28.96, while in the fourth the index was as low as 9.85.

In Series II the one control had an index of 8.26. Infundibular lesion was unsuccessful in 2 animals; their index was 9.50. The average index for 5 of the successfully lesioned 6 animals was 21.63. In the sixth successfully lesioned animal the index was 12.58 (Table I).

Table I.



Control. Partial lesion of the pituitary stalk
Total lesion of the pituitary stalk
No JGC effect in spite of total infundibular lesion. The JGC index is indicated along the vertical axis; the thick line across each group of columns and the number indicate the average index of the group. Weight of the adrenals is given in mg below the columns

The 3 control animals of the two series, as also those 5 animals in which we had failed to injure the whole of the pituitary stalk, so that they may to some extent likewise be regarded as controls, displayed a low index, the range of which was comparable to that for our normal stock of Wistar rats.

The difference between the positive cases of Series I and Series II must have been due to the different survival times: in Series I there was less time for the changes to develop.

Every significant rise in the JGC index was accompanied by a considerable decrease in the weight of the suprarenal glands, to 20 mg, sometimes even less.

The hypothalamus, the pituitary, adrenal and thyroid glands and the gonads were all reduced in weight and exhibited atrophy and histological signs of hypofunction. In animals with a lesion extending to the whole infundibulum, the atrophy and lipoid depletion of the fasciculate and reticular zones showed a striking contrast to the broadened and sudanophilic zona glomerulosa. We cannot go beyond mere conjectures in respect of those two test animals which gave a negative response to the successful lesion. The injury of some hypothalamic structure may have prevented in these cases a hypergranulation of the cells of the juxtaglomerular apparatus.

Discussion

According to the literature, adrenalectomy or a salt-deficient diet is followed by a significant rise of the JGC index. Several authors observed a broadening of the zona glomerulosa in animals kept on a salt-deficient diet, and regarded the abnormally low blood sodium level as the primary factor. Having performed no chemical analyses, we cannot tell whether hyponatraemia did or did not occur in our animals; the observed hypergranulation of the JGC seems to point to an increased loss of sodium as the fundamental alteration, an assumption well in harmony with the histological picture of the adrenal cortex. We attribute the high index as well as the hypertrophy of the zona glomerulosa to the infundibular lesion. This might have influenced the zona glomerulosa directly and been the indirect cause of the hyperplasia and hypergranulation of the JGC. It is, however, possible that the two effects were independent of each other. Our experimental results point to the possibility of a hypothalamic regulation of the zona glomerulosa and the juxtaglomerular apparatus.

Summary

In the kidney of rats with infundibular and tuberal lesion hyperplasia and hypergranulation of the juxtaglomerular cells were observed with atrophy of the adrenals accompanied by a broadening of and lipoid accumulation in the zona glomerulosa. The two changes went parallel and were presumably induced by the lesion of the hypophyseal-hypothalamic system.

REFERENCES

1. GOORMAGHTIGH, N. (1939): Existence of an Endocrine Gland in the Media of the Renal Arterioles. Proc. Soc. exp. Biol. and Med. (N. Y.) *42*, 688. — 2. GOORMAGHTIGH, N. (1949): Démonstration des cellules endocrines de la paroi artériolaire du rein ischémique. Belg. Nederl. Cyto-embryol. Dagen, Gent p. 11. — 3. HARTROFT, PH. M.—HARTROFT, W. S, (1953): Studies on Renal Juxtaglomerular Cells. I. J. exp. Med. *97*, 415. — 4. HARTROFT, PH. M.—HARTROFT, W. S. (1955): Studies on Renal Juxtaglomerular Cells II. J. exp. Med. *102*, 205. — 5. PITCOCK, J. A.—HARTROFT, PH. M. (1958): The Juxtaglomerular Cells in Man. Amer. J. Path. *34*, 863. — 6. ENDES, P. (1954): Kombinált trichrom festés (Combined Trichrome Staining). Kísérl. Orvostud. *6*, 479.

Prof. Pongrác ENDES
Dr István DÉVÉNYI
Dr Szabolcs GOMBA
Debrecen, 12., Kórbonctan, Hungary

Dr Béla HALÁSZ
Pécs, Dischka Gy. u. 5., Hungary

A kiadásért felel az Akadémiai Kiadó igazgatója Műszaki szerkesztő: Farkas Sándor

A kézirat nyomdába érkezett: 1960. III. 2. — Terjedelem: 12,50 (A/5) ív, 83 ábra (35 színes), 11 melléklet

1960.50942 — Akadémiai Nyomda, Budapest — Felelős vezető: Bernáth György