

EFFECT OF PERIRENAL PROCAINE BLOCK
ON ZINC CONTENT IN THE PANCREAS,
HISTOPHYSIOLOGY OF ITS INSULAR APPARATUS,
AND SENSITIVITY OF ALBINO RATS TO INSULIN

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Bilateral perirenal block with 0.5% procaine solution stimulates the function of the β -cells of the islets of Langerhans and increases the sensitivity of rats to insulin, the zinc content in the β -cells of the islets being increased under these conditions.

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To study the effect of nerves on various structures, the use of the procaine block has been recommended [3]. Blocking the splanchnic nerves with procaine has been shown to lower the blood sugar and to increase sensitivity to insulin [4]. Perirenal block by Vishnevskii's method has been used successfully for the treatment of severe or moderately severe forms of diabetes mellitus [2].

The object of the present investigation was to study the effect of perirenal procaine block on the histophysiology of the insular apparatus of the pancreas and the sensitivity of albino rats to insulin. Besides determining the blood sugar and comparing the endocrine part of the pancreas with its exocrine part, as a reliable morphological test of islet-cell function, the content and distribution of zinc in these cells was also studied.

Zinc is present in the pancreas mainly in the cytoplasm of the α - and β -cells. When function is increased the zinc content of the cells is high, and when function is decreased the zinc content is low [8]. Evidence of the role of zinc in diabetogenesis has been reported [9, 11].

EXPERIMENTAL METHOD

Experiments were carried out on 135 male albino rats weighing 150-200 g, subdivided into 5 groups. Group 1 (control) included 20 intact rats. The animals of group 2 underwent bilateral perirenal block daily with 0.5% procaine solution in a dose of 1 ml/100 g body weight; 3 rats were sacrificed 2 h, 24 h, and 7 days after the first block, and 48 rats after 10 blocks. The animals of group 3 (19) received procaine in the same dose as those of group 2, but subcutaneously. The rats of group 4 (19) received injections of isotonic sodium chloride solution into the perirenal cellular tissue in a dose of 1 ml/100 g body weight. In the rats of group 5 (10 animals) the hypoglycemic effect of insulin (2 units/kg body weight) was studied. Ten days later these animals were injected with the same dose of insulin against the background of the perirenal block, and the blood sugar level was again investigated.

The blood sugar was determined by the Hagedorn-Jensen method: in the animals of groups 2-4 using twice the test dose of glucose (2 g/kg body weight), before the experiment, 1 h after the first block (or the subcutaneous injection of procaine or injection of isotonic sodium chloride solution into the perirenal space respectively), and 24 h after the 10th block.

The distribution of zinc in the pancreas was determined by the silver sulfide method [11], and its content was estimated polarographically [1].

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EXPERIMENTAL RESULTS

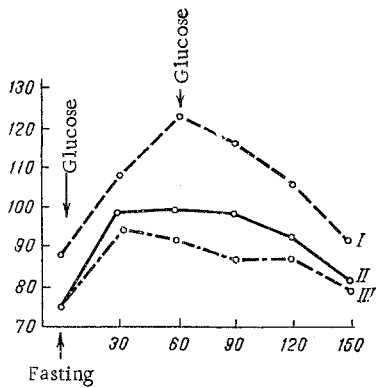


Fig. 1. Blood sugar curves before (I) and 1 h (II) and 24 h (III) after the 10th procaine block. Abscissa, time (in min); ordinate, blood sugar (in mg%).

One h after the block the blood sugar was lowered from 88 ± 2 to 76 ± 1 mg% ($P < 0.01$). Subcutaneous injection of procaine and isotonic saline into the perirenal cellular tissue did not affect the blood sugar level. The blood sugar curves 1 h after a single block (Fig. 1, II) and 24 h after the 10th block (Fig. 1, III) were strongly hypoglycemic in character: low initial level of the blood sugar (76 ± 1 mg%), slight increase after administration of a double test dose of glucose (hyperglycemic coefficient 30 and 24% respectively, compared with 38% before the block). Curves of this type occur in hyperinsulinemia [10].

The perirenal procaine block sharply increased sensitivity to insulin. Before the block, the hypoglycemia 120 min after injection of insulin (2 units/kg) was moderate (62 ± 2 mg%), but 150 min after the block a tendency was observed for the blood sugar level to return to normal. The same dose of insulin given to the same rats against the background of the procaine block lowered the blood sugar after 120 min to 36 ± 3 mg%. Meanwhile hypoglycemic convulsions were observed in all the animals. Histological examination of the pancreas after the

block showed severe hyperemia. The Richardson-Young index was increased from 0.65 in the control animals to 0.8 in the experimental animals.

Zinc in the islets of Langerhans of the control rats was distributed in the cytoplasm of the α - and β -cells. The α -cells contained more zinc, so that they were clearly distinguished around the periphery of the islet by their dark brown color (Fig. 2a). Traces of zinc were observed in the exocrine part of the gland. The zinc content determined polarographically was $16 \mu\text{g}$ in the control rats and $30 \mu\text{g/g}$ fresh weight of pancreas after 10 blocks. The increase in the zinc content took place as a result of its accumulation in the cytoplasm of the β -cells. In sections treated by the silver sulfide method, the islets appeared black (Fig. 2b). A considerable increase in the zinc content also was observed 2 h, and 1 and 7 days after a single procaine block.

After subcutaneous injection of procaine and injection of isotonic sodium chloride solution into the perirenal cellular tissue, the zinc content in the islets of Langerhans was the same as in the intact rats.

The morphological changes developing in the pancreas after procaine block thus demonstrate an increase in the function of the β -cells of its insular apparatus. Similar results were obtained after division of the splanchnic nerves [5]. Since subcutaneous injection of procaine did not give this effect, it can be assumed that the influence of the perirenal procaine block on the islet-cell apparatus is effected through removal of the inhibitory effect of the sympathetic innervation on the β -cells. Division of the splanchnic nerves [7] or their blocking by procaine [6] stops the formation of adrenalin and its liberation into the blood

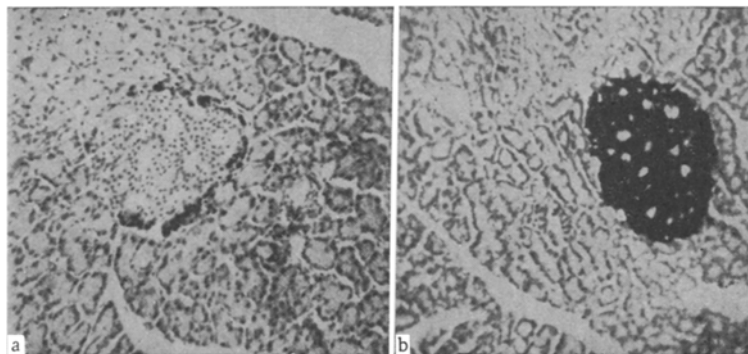


Fig. 2. Zinc in the pancreas of an intact rat (a) and after 10 perirenal procaine blocks (b). Silver sulfide method, stained with hematoxylin, $63\times$.

stream. The morphological changes in the islets of Langerhans observed in the present experiments were evidently due to the blocking of their sympathoadrenal regulation.

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