EFFECT OF DEHYDRATION ON THE INTERSTITIAL CELLS OF THE RENAL PAPILLA

E. G. Antonova and G. V. Pravotorov

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The population of interstitial cells at the base of the renal papilla of the albino rat consists of cells of two types which differ in the degree of development of the endoplasmic reticulum. In intact rats, cells with a weakly developed reticulum predominate. Dehydrated animals are characterized by cells with a well-developed reticulum. It is submitted that the main function of the interstitial cells is connected with the activity of the granular endoplasmic reticulum.

KEY WORDS: kidney; dehydration; interstitial cells.

The role and origin of the interstitial cells of the renal medulla has not yet been explained. These cells hypothetically perform several functions [5-9]. Because of their morphological features, the interstitial cells are regarded by some investigators as cells of a special type which differ from other connective tissue cells [4].

The object of this investigation was to study the composition of the interstitial cell population and also the direction and degree of ultrastructural changes taking place in the interstitial cells in response to dehydration.

EXPERIMENTAL METHOD

Interstitial cells at the base of the renal papilla were investigated in noninbred albino rats – 5 intact animals and 5 subjected to strictly dry feeding for 10 days. The rats of the control group had free access to water, whereas animals of the experimental group were completely deprived of water. The animals of both groups received dried food (with a moisture content of about 13-15%).

Material for electron microscopy was fixed in 2.5% glutaraldehyde in 0.15M phosphate buffer and then postfixed in 1% OsO_4 in 0.075 M phosphate buffer with the addition of 0.045 g sucrose to 1 ml fixative. The material was then embedded in Araldite. Sections were stained with lead citrate.

For the morphometric study, 100 cells from each group of animals (20 cells per animal) were photographed. Under a final magnification of 25,000× the measurements were made with a regular morphometric grid with a step of 1 cm. The relative volume of all the organelles in the cytoplasm (the degree of saturation of the cytoplasm with organelles), and the volumes of mitochondria, endoplasmic reticulum, lipids, lysosomes, vacuoles, and phagosomes in it were calculated by means of stereological equations. The surface of the cisterns of the reticulum and Golgi apparatus was determined as the ratio between the number of times test lines intersected the cross sections of the cisterns and the number of points falling on the cytoplasm of the cell, multiplied by 100. The mean volume of the organelles was estimated.

The heterogeneity of the population was studied by discriminant analysis, whereby biological objects can be classified on the basis of quantitative indices [2]. Classification problems were solved by the Minsk-32 computer, programmed for discriminant analysis [1]. The cells were analyzed on the basis of 11 indices. Since groups of cells may differ in respect to several features, the informativeness of each feature was determined [3]. Values of informativeness are not given in the text, but when differences between groups are described, the features are arranged in order of decreasing informativeness.

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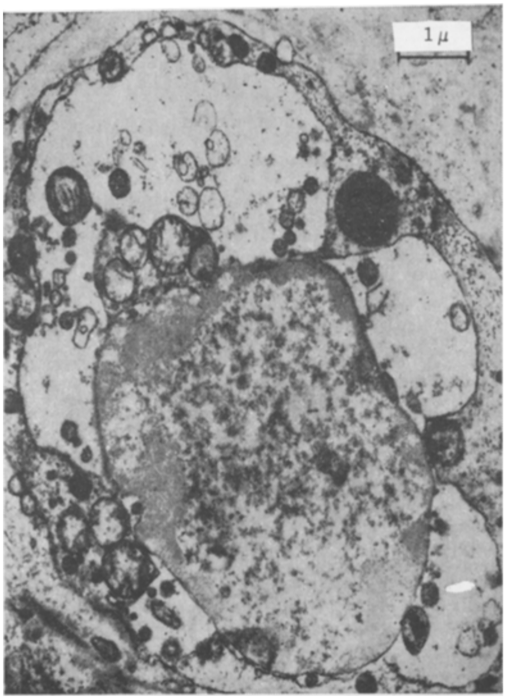

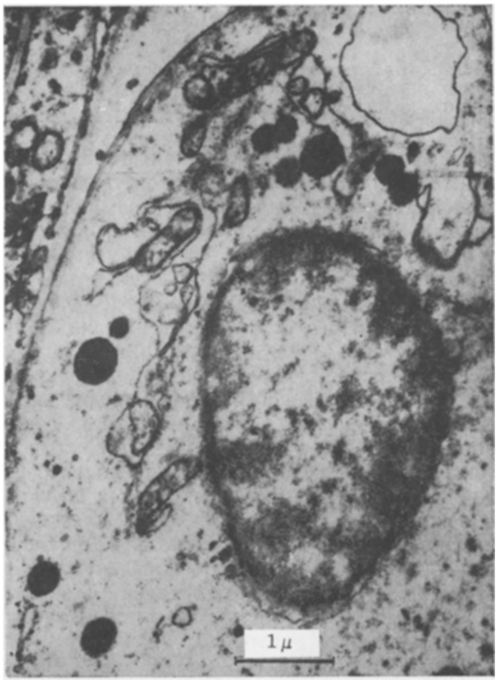

Fig. 1 Fig. 2

Fig. 1. Interstitial cell of renal papilla with well-developed reticulum (first type of cell) from intact albino rat.

Fig. 2. Interstitial cell of renal papilla with poorly developed reticulum (first type of cell) from intact albino rat.

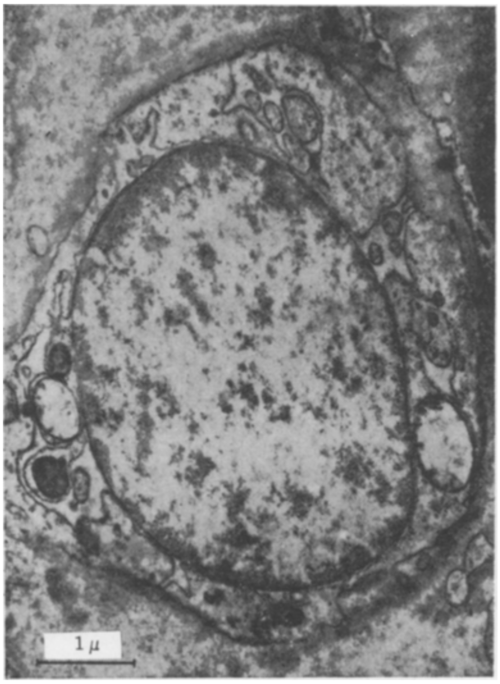

Fig. 3. Interstitial cell of renal papilla of albino rat with well-developed reticulum (second type of cell) on 10th day of dehydration.

EXPERIMENTAL RESULTS

In the intact rats, the interstitial cells were poor in organelles. The mean saturation of the cytoplasm with organelles was 10.63 ± 0.85%, of which 4.92 ± 0.78% was accounted for by the rough endoplasmic reticulum. The two indices correlate closely: the coefficient of linear correlation for them is 0.89 ± 0.04, whereas for all other organelles it is below 0.5. The surface area of cisterns of the reticulum was 35.9 ± 2.57 units, the volume of the mitochondrial fraction 2.16 ± 0.22%, and the lipid content 3.64 ± 0.45%. There were not more than 1% of lysosome-like structures in the cells. The Golgi complex was poorly developed and was found in only 1 out of every 4 cell profiles examined.

Widening of the perinuclear space is a characteristic feature of the interstitial cells. At times it was impossible to decide where the nuclear membrane ended and the cisterns of the reticulum began. For that reason, the widened perinuclear space (Fig. 1) was classed as cisterns of the reticulum. Depending on the development of the reticulum, the interstitial cells could be divided into two types. Cells of the first type had a poorly developed reticulum, with a surface area of 26.84 ± 1.76 units (Fig. 2), cells of the second type had a well-developed reticulum, the cisterns of which could be either flattened (Fig. 3) or swollen (Fig. 1). The surface area of the cisterns in this group was 77.33 ± 8.75 units. Most cells in intact rats had a poorly developed reticulum: only 12% of cells had a well-developed reticulum. Intermediate forms exist between the first and second types. This heterogeneity of the interstitial cell population can be presumed to be due to differences in their functional activity.

After dry feeding for 10 days the ultrastructure of the "average" interstitial cell was significantly modified. The saturation of the cytoplasm with organelles was increased by 2.4 times (25.66 ± 1.42%). This was due to the development of the reticulum, the surface area of which was increased to 74.38 ± 3.42 units, and to a threefold increase in the volume of the mitochondria (6.66 ± 0.5%). The saturation of the cytoplasm with organelles, as before, depended on the volume of the reticulum (the coefficient of linear correlation between them was 0.89 ± 0.04). Besides reduction of the cristae by 47% the mean volume of the mitochondria was increased (from 1.02 ± 0.1 to 1.91 ± 0.12 respectively). The lipid content was reduced by three-quarters (0.92 ± 0.15%), although it should be pointed out that this last feature was the least informative of all.

In the experimental animals the composition of the interstitial cell population was changed. The proportion of cells of the second type (cells with a well-developed reticulum) was increased and they now accounted for more than half of the population. The number of intermediate forms was considerably increased. Changes affected cells belonging to the first type: in the experimental animals the reticulum had a larger surface area (48.7 ± 3.38) than in the control, the volume of the mitochondria was increased to 6.7 ± 0.5% from the normal 2.06 ± 0.2%, and the lipid content was reduced from 3.01 ± 0.44 to 0.27 ± 0.11%.

The population of interstitial cells at the base of the papilla is thus heterogeneous in its ultrastructure. This heterogeneity is probably due to differences in the activity of the cells. After dehydration the fraction of cells with a well-developed reticulum increases considerably. If the interstitial cells can be assumed to participate in the function of the concentrating apparatus of the kidney, their main activity in this respect is connected with the production of proteins synthesized by the granular endoplasmic reticulum.

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