

# FUNCTION OF THE STRUCTURES OF THE NEPHRON IN A FOCUS OF SCLEROSIS

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To determine the end result of the sclerotic changes in the kidney, and the possibility and limit of their regression and of restoration of the normal structure of the organ, nephrosclerosis was produced in one kidney of a rabbit by multiple-point thermocoagulation of the renal cortex [6].

During the investigation of the kidneys of animals 19 months after thermocoagulation, definite restoration of the anatomical relationships between the renal capsule and cortex was observed, and this was associated with the regeneration and hypertrophy of the convoluted tubules and with hypertrophic and hyperplastic processes in the Malpighian bodies remaining intact in the zones of sclerosis [7, 16].

This process may be accelerated by increasing the functional load on the organ. In the present experiments this increase in the functional load was brought about by removal of the opposite healthy kidney. In this case signs of compensatory hypertrophy developed in the affected kidney [4, 5, 7, 9].

The object of the present investigation was to study whether the Malpighian bodies and the convoluted tubules persisting in the zones of sclerosis are functional, and whether the normalization of these structures during their transition from a state of atrophy and sclerosis to hyperplasia and hypertrophy is the result of the functional effort of the structures as they return to normal.

According to reports in the literature on regeneration of the kidney, the regenerating tubular structures are nonfunctional [3, 13, 15, 18].

The conclusions drawn by these investigators are based on observations made relatively soon after trauma, and they concern tubules regenerating in the period of development of granulation tissue at the site of injury. The author agrees with this conclusion, with the reservation that a few of these regenerating tubules may be found at longer intervals after injury, in the collagenous scars of the renal cortex. At the same time, the author has not observed and cannot confirm the progressive character of the sclerosis of the tubules at longer intervals (over 2 months) after the onset of the lesion, when the causes of development of the sclerosis have ceased to act. Conversely, in cases over 1 year in duration, replacement of the zones of sclerosis by zones of convoluted tubules with a stroma indistinguishable from normal is clearly visible [7].

The problem of the function of the Malpighian bodies is unanimously agreed to be associated with the preservation of the vascular network of the glomerulus [4].

The work of D. N. Nasonov, N. G. Khlopin, and V. Ya. Aleksandrov has shown that granule formation during vital staining of the tissues may be used as evidence of the normal functioning of the cells [1, 2, 10-12, 17].

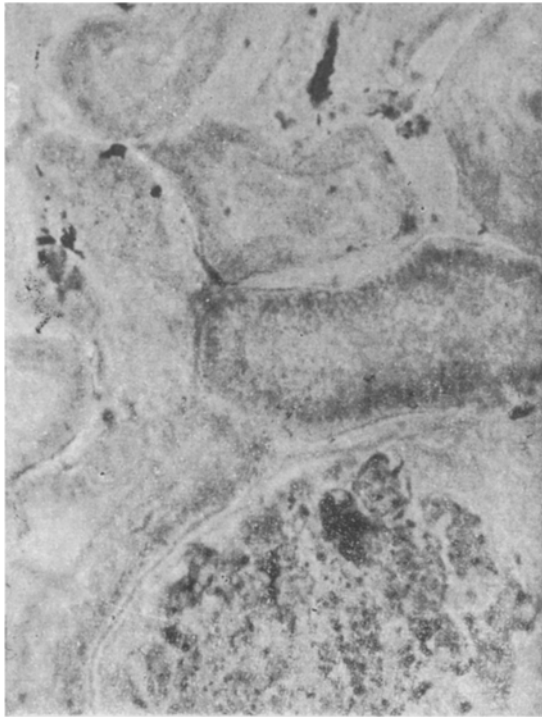
## EXPERIMENTAL METHOD

Experiments were carried out on 10 intact and 6 experimental rabbits. Experimental group 1 included animals with nephrosclerosis induced in the left kidney and a normal right kidney. The times after thermocoagulation were 60, 90, and 527 days. Experimental group 2 included rabbits from which the intact kidney was removed 2 months after thermocoagulation of the opposite kidney. The intervals after thermocoagulation in the experimental animals of group 2 were 90, 273, and 573 days.

Trypan blue was chosen as the dye. It is known to be eliminated in the form of granules in the main portions of the convoluted tubules of the kidneys [8, 17]. To detect the vascular network of the Malpighian body, a 10%

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Scar in a rabbit's kidney 527 days after thermocoagulation. Granule formation in the epithelium of the regenerating tubules. Deposition of collargol in the vessels. Unstained preparation. Magnification 530 x.

of colloidal silver were found in all the glomeruli, and their number varied fairly widely from one glomerulus to another.

In a rabbit undergoing thermocoagulation 2 months previously, many tubular structures with accumulations of granules of dye in their epithelium were seen in the scars in the cortical layer and at their borders. In other animals of this group there was an appreciable increase in the number of tubules and of isolated bands of tubular epithelium without a lumen or with a small lumen in the scars, especially in their peripheral portions, with an increase in the time after thermocoagulation. The intensity of accumulation of granules in these structures also differed. No difference could be detected in the pattern of accumulation of trypan blue between the epithelium of the tubular zones formed in the late stages in the zones bordering on the scars and the epithelium formed earlier.

The injection material (collargol) was found in all the glomeruli of all the zones of the cortex, including the glomeruli situated inside the scars. The connective tissue of the capsules of the sclerosed Malpighian bodies was stained diffusely with trypan blue (see figure).

In the kidneys of the experimental animals of group 2 (with unilateral nephrectomy) the morphological picture of vital staining and vital injection of the blood vessels was identical with that described above. In the animal on which nephrectomy was performed a short time (12 days) before the experiment the differences in the intensity of accumulation of the dye granules in the various parts of the convoluted tubules were rather more marked.

Hence, no differences were found in the accumulation of trypan blue granules in the epithelium of the tubules of the undamaged nephrons and of the tubules located in the scars. Slight degrees of functional strain likewise failed to reveal any visible differences in granule formation by the epithelium of the tubules associated with the scars and by the epithelium of the tubules in normal areas of parenchyma. The observed increase in the intensity of accumulation of granules of dye by particular areas of the convoluted tubules in the first period after nephrectomy was most probably connected with the physiological changes characteristic of this period. The Malpighian bodies remaining in the zones of sclerosis in the late stages of experimental nephrosclerosis retained their vascular network.

solution of colloidal silver was used. The solution of trypan blue (10%) in 0.9% sodium chloride solution was injected into the auricular vein of a rabbit in a dose of 1 ml/100 g body weight. The injection was repeated 24 h later. A subcutaneous injection of 0.5 ml heparin was given to the animal 48 h after the first injection of the dye. Under deep ether anesthesia, 30 min after the injection of heparin, an intravenous injection of colloidal silver (collargol) was given. Before cardiac activity and respiration ceased, which usually took place after a dose of about 15 ml/kg body weight of the solution, the kidneys were quickly extracted, cut into two parts, and fixed in 10% formalin solution. After 24 h the sections cut on a freezing microtome were dehydrated and mounted in Canada balsam.

## EXPERIMENTAL RESULTS

The cut surface of the kidneys of the intact animals was bluish-brown in color, the boundary between its layers was clearly distinguishable, and the mucous membranes of the pelves and ureters was stained blue. The kidneys of the experimental animals differed from those of the intact rabbits only in the sclerotic changes in their cortical layer and capsule, which showed up white in color on the surface.

On microscopic investigation of the kidneys of the intact animals a regular pattern of accumulation of granules of the dye in the epithelium of the main portions of the tubules in the cortex was observed. Slight differences were noted in the intensity of accumulation of the granules in the cells and in their arrangement within the cell. Particles

It may be concluded from the facts described above that the structures of the kidney undergoing repair, regeneration, hyperplasia, and hypertrophy in the process of regression of experimental nephrosclerosis are functional. Further investigations are required to determine the qualitative and quantitative characteristics of this function.

#### SUMMARY

Renal canaliculi becoming restored in the process of the reverse development of experimental nephrosclerosis are capable of forming in their epithelium granules of trypan blue, which may be an evidence of their functioning. Hypertrophy affects only those Malpighian bodies in which the vascular network is preserved.

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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.

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