108. *The Influence of the Renal Nerves on the Excretion of Urine.*

(The Changes in the Renal Blood Flow caused by the Drugs which act upon the Sympathetic or Para-sympathetic Nerve-endings.)

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It is a well-known fact that the excretion of urine is influenced by the renal nerves; but whether there is really such a specific secretory nerve as comparable to that of the submaxillary gland or not is not yet confirmed, although Asher¹⁾ and his pupils once suggested the existence of it. On the other hand, no one doubts that the urine excretion in the kidney, unlike the secretion in the other glands, has a very close relation to the renal blood supply.

In the present experiments, therefore, to elucidate the relation of the renal nerves to the renal blood circulation, the changes in the renal blood flow and the excretion of urine induced by the drugs which act upon the sympathetic or para-sympathetic nerve-endings were closely observed, various methods being applied on amphibian and mammalian kidneys.

Direct Microscopic Observation of the Frog's Kidney in situ. The frog's kidney was exposed by Tamura²⁾ and his co-workers' method and the diameter of the small arteries in the kidney was measured under a microscope by the direct observation before and after the injection of drugs. After an injection of pilocarpine, (0.1 c.c. of 1% pilocarpine nitrate solution, intravenously), the diameter of the small artery in the kidney increased; while a small dose of atropine (0.05 c.c. of 1% atropine nitrate solution, intravenously) was sufficient to cause vaso-dilation to some extent. As for adrenaline, directly after its injection (0.05 c.c. of 0.1% solution, intravenously), the small artery in the kidney contracted, but in a few minutes it dilated distinctly more than before the injection.

1) Asher u. Pearce, Zeitschr. f. Biol., 63 (1913), 83.

2) Tamura, Miyamura, Nishina and Nagasawa: Proc. Imp. Acad., 2 (1926), 74.

Observation of the Renal Blood-Flow in Rabbits. A measurement of the renal blood-flow was carried out in rabbits prepared after the Barcroft-Brodie's method. In an animal to which a very small dose of atropine was given to prevent the fall of the general blood-pressure to be caused by pilocarpine, an intravenous injection of pilocarpine (0.3 c.c. of 10% pilocarpine nitrate) was followed by an acceleration of the renal blood-flow, with an increase in the urine outflow, but without any change in the blood-pressure. When atropine (0.25 c.c. of 1% solution, intravenously) was introduced, the blood-flow through the kidney slowed down with a decrease in the urine outflow, while the blood-pressure remained without any perceptible change. Adrenaline, when injected intravenously, caused a very rapid rise of the general blood pressure; but the blood-flow through the kidney was greatly reduced, showing an extremely powerful renal vaso-constriction; and the amount of urine excreted diminished.

Artificial Perfusion of the Toad's Kidney. For the artificial perfusion of the toad's kidney, Schmidt's¹⁾ method was adopted; and the saline solution modified by Barkan, Broemser and Hahn²⁾ was used as an artificial blood. Whenever pilocarpine (0.1% to 0.01% in the artificial blood) was perfused through the kidney, the amount of the discharged artificial blood increased, showing a vaso-dilation in the kidney; and the urine outflow also increased. On the contrary, when atropine (0.1% to 0.02% in the artificial blood) was perfused, the outflow of the perfusion fluid through the kidney decreased, showing a vaso-constriction in the kidney; and the urine outflow also decreased correspondingly. Directly after an injection of adrenaline (0.1 c.c. of 1:1,000,000 to 1:10,000,000) the outflow of the perfusion fluid through the kidney distinctly decreased with a diminution of the urine outflow, showing a renal vaso-constriction.

Artificial Perfusion of the Mammalian Kidney. In order to maintain the physiological permeability in the isolated kidney as much as possible, the blood supply to the kidney was persistently continued, during the preparation, by infusing warm oxygenated saline solution into the aorta of rabbits and dogs at a couple of centimetres distance from the branching off of the renal arteries, and then the aorta was ligatured to isolate the kidney.

After an injection of pilocarpine (0.2 c.c. of 2-10% solution into the rubber tubing for perfusion) the outflow of the perfusion fluid through the kidney increased, owing to a vaso-dilation in the kidney; and it was

1) Schmidt: Pflüger's Arch. f. d. ges. Physiol., 48 (1891), 34.

2) Barkan, Broemser and Hahn: Zeitschr. f. Biol. 74 (1921), 1.

followed by an increase in the urine outflow. Atropine (1 c.c. of 2% solution), when injected into the rubber tubing for perfusion, caused some decrease in the perfusion fluid, showing a vaso-constriction; and it also caused some decrease in the urine excretion. Adrenaline, when injected, produced an intense vaso-constriction and a marked decrease in the excretion of the urine.

These experimental results indicate clearly that those drugs which stimulate para-sympathetic nerve-endings cause a renal vaso-dilation, while those which paralyse para-sympathetic nerve-endings, some renal vaso-constriction; and those which stimulate sympathetic nerve-endings, a renal vaso-constriction and that the changes in the blood circulation produced by such drugs are accompanied by proportional changes in the urine excretion.

It is evident, therefore, that in the study of the direct influence of renal nerves on urine-formation, those indirect influences which are caused by the changes in the renal blood circulation must be excluded completely.