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Fluorescent Granules at the Glomerular Pole of Human Kidneys.*

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An agglomeration of granulated cells at the glomerular pole of the kidney has been described[1,2,3] close to the part of the distal convoluted tubule with densely arranged cells (macula densa).[4] The granulated cells, originally compared with "epitheloid" cells of arteriovenous anastomoses,[5] were called neuromyoarterial juxtaglomerular apparatus by Goormaghtigh.[6] Observing hypertrophy and increased granularity of these cells in experimental renal hypertension, he[7] considered them as the source of the pressor substance, renin. Studies[8,9] on hypertensive rabbits supported this idea. Similar cells—apparently transformed smooth muscle cells—but without granules, were also seen in man; in hypertension they appeared hypertrophic.[10] Recent investigations,[11] however, indicate that renin is produced in the renal tubules.

The possible significance of the juxtaglomerular apparatus justifies description of new morphologic findings in this area. After short fixation in formalin, frozen sections of human kidneys were examined under the fluorescence microscope. Sometimes a sharply circumscribed agglomeration of fine granules with whitish to gold brown, not fading, fluorescence was seen at the glomerular pole (Fig. 1B). The granules surround or even invade the wall of the arteriole—recognized by blue fluorescent fibers—at its entrance into the glomerulus. A few granules may be found farther along the arteriole outside or inside the glomerulus. In other glomeruli the granules are seen on one side of the arteriole only, in a circumscribed ovoid area. The fluorescence was not changed by oxidizing or reducing agents, acid or alkali. Lipoid solvents reduced the fluorescence only after prolonged treatment; after paraffin embedding it was lost.

For exact localization of the fluorescent granules, sections were slightly stained with hemalum. This does not interfere with the fluorescence but allows observation of the same area in visible light. Thus the granules were found in the same area where in visible light the juxtaglomerular apparatus was seen, the outer limits of fluorescence and apparatus being identical. If a macula densa was visible, the granules extended up to it (Fig. 1A).

Kidneys of different individuals (107 cases) showed great variations in number, size, and fluorescence of the granules which were uniform in glomeruli of the same kidney. Their presence and number were independent of the development of the juxtaglomerular apparatus. Sometimes the granules were absent from a large apparatus. The fluorescent granules, absent in children, increased in number with age. They were numerous and relatively large in general exhaustion with brown atrophy of the organs. The fluorescence was usually striking in hypertension without renal involvement but reduced with renal involvement. In chronic nephritis it was reduced or absent. In hyalinizing glomeruli, the fluorescence may

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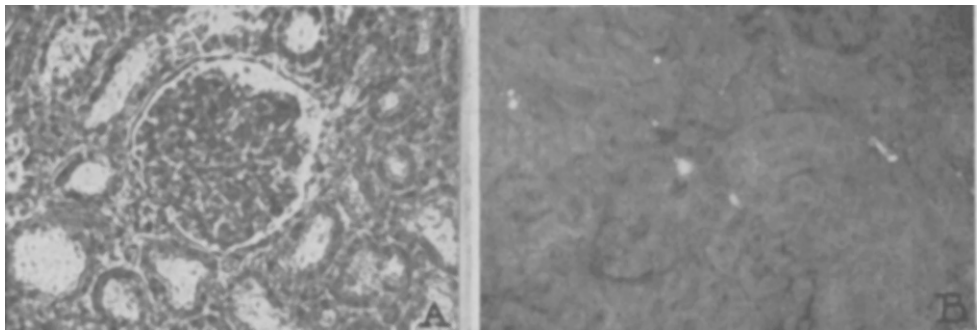

FIG. 1.
Juxtaglomerular apparatus of human kidney: (A) In visible light, agglomeration of cells close to macula densa (part of distal convoluted tubule with densely arranged nuclei). (B) In ultra-violet light, fluorescent granules on the glomerular pole.

remain in characteristic localization even if the nuclei of the juxtaglomerular apparatus have disappeared.

Besides these granules the following fluorescent details are occasionally found in human kidneys: irregularly formed large particles in scars, sclerotizing or hyalinized glomerularized or arteriosclerotic vessels; ultra-violet labile vitamin A fluorescence of lipoids in pathologic conditions;[12] and brown fluorescent granules in tubular epithelium. The fluorescence of these latter two is of different character.

In kidneys of monkeys, dogs, cats, mice, rats and rabbits no fluorescence was found at the glomerular pole. It was absent in dogs with experimental renal hypertension.†

The fluorescent granules are not a normal characteristic of the juxtaglomerular apparatus and not related to the granules seen in visible light in animals. Age distribution, solubility, localization in modified smooth muscle cells, and character of fluorescence[13] justify their interpretation as wear and tear pigment. Their deposition into the apparatus is probably a common process, comparable to lipoid deposition in arteriosclerosis. The fluorescence is not related to renin since renin preparations showed no characteristic fluorescence.‡

Conclusions. Fluorescent granules are sometimes found at the glomerular pole of human kidneys. They are absent in normal animals and in dogs with experimental renal hypertension.

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† Thanks are due to Dr. H. Goldblatt and Dr. G. E. Wakerlin for kidney specimens of dogs with experimental renal hypertension.

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