ANATOMY OF THE GLOMERULUS AS OBSERVED IN BIOPSY MATERIAL FROM YOUNG AND HEALTHY HUMAN SUBJECTS

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With 18 Figures in the Text

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I. Electron microscopic investigation of the capillary wall

Reports on electron microscopic investigations of the normal anatomy of the renal glomeruli in different experimental animals have been published by a number of authors during recent years. (References in BERGSTRAND 1957.) A few studies have also been performed on the pathological changes in the glomeruli of human subjects suffering from various diseases (BERGSTRAND and BUCHT 1956, 1957, FA~I~R et al. 1957a and b).

Obviously observations on the normal anatomy of the glomerulus which have been made in experimental animals, are no safe basis for a discussion of pathological changes in man. It may be presumed that the electron microscope which has made visible so many and important cell structures will also reveal important differences between the human kidney and that of, for instance, the rat or mouse.

Therefore we have started a study of the different parts of the nephron in the human kidney with the aid of the electron microscope regardless of the fact, that much of this work will presumably not reveal anything that is not known from previous investigations on experimental animals. In this paper we will give a report of our investigations of the glomeruli in young and healthy human subjects. As far as we have been able to find out only MUELLER et al. (1955) and FA~I~R et al. (1957a) have previously made a similar investigation. These authors have not observed any differences between the human glomerulus and those of animals (dogs).

Material and methods

Renal biopsy has been performed according to KARK and MUEHCKE (1954) on three male patients from the surgical wards.

Pat. 1 was 22 years old and was operated upon for an inguinal hernia.
Pat. 2 was 18 years old and was operated upon for a phimosis.
Pat. 3 was 29 years old and was also operated upon for an inguinal hernia.

Neither of them had any signs of renal disease and all renal function tests were within normal limits. Thus blood pressure, sedimentation rate, non-protein nitrogen, endogenous creatinine clearance and urin analysis did not show anything pathological.

The biopsy material was immediately divided into two parts. One was fixed in 10 per cent formalin and the other in a 1 per cent solution of osmium tetroxide buffered at pH 7.2. After the fixation the material was treated for light microscopy and electron microscopy in the same way as described in a previous paper (BERGSTRAND and BUCHT 1957). The fixation in osmium tetroxide was started within three minutes after the biopsy was completed in all three cases.

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After the embedding in the methacrylate mixture the blocks were preliminarily trimmed in such a manner that the upper surface was formed into an irregular polyhedron with a surface of about 1 mm². Sections with a thickness of 5 to 10 microns were cut from the blocks with an ordinary microtome. The sections were examined in a light microscope or a phase contrast microscope. The glomeruli could be easily observed and afterwards localized in the blocks with the aid of scratches on the surface of the section or the irregular form of the tissue. The blocks were then definitely trimmed to sharp cones previous to the sectioning which was performed with a glass knife in a Sjöstrand ultramicrotome.

In a few cases sections with a thickness of 0.5 to 1 micron were cut on the Sjöstrand microtome before the definite sectioning for electron microscopy. These sections were studied in the phase contrast microscope in order to obtain more detailed pictures with this technique than is possible with sections 5 to 10 microns thick. Thus each glomerulus was examined with or din~ry histological methods, except stainings, before the sectioning for electron microscopy. The electron microscope used was an RCA EMU 2 d with an intermediate lens, a condenser aperture of 0.01 inches and an objective aperture of 0.003 inches in diameter, adjustable from the outside (Canaleo).

Results

The observations in the light microscope will be described in part II of this work (p. 63).

A survey picture at low magnification shows the same general structure in the glomerulus as we have previously described in animals (Fig. 1). The basement membrane and the epithelial cells of the capsule of Bowman do not show anything of special interest. A large free space is observed between the capillary walls and Bowman’s capsule in the whole of the glomeruli except at the vascular pole both in the formalin fixed material and that fixed in osmium tetroxide.

The glomerular capillary wall is built in the same way in humans as in animals (Figs. 1, 2). Some differences are observable even at this low magnification, however, mainly in the endothelial cells and the basement membrane.

The endothelial cells. In most cases there is a continuous, very thin layer of endothelium on the inside of the capillary wall (Figs. 1, 2, 4, 7). In most experimental animals a large number of rounded discontinuities or “holes” are regularly observed in the cell membranes and cytoplasma of the endothelial cells (Fig. 3). In the human glomeruli such phenomena are observed but occasionally (Fig. 4), and are much more rare than in the animals.

In the cytoplasm of the endothelial cells small cell organelles such as small vesicles and very dense granules with a diameter of 100—150 Å are observed. Similar granules have been described inter al. by Sjöstrand, and Rhodin (1953), Palade (1955), and Sjöstrand (1956) in different cells from experimental animals. They may be diffusely distributed in the cytoplasma or may be arranged in clusters, circles, rosettes etc. In the present case they are assembled in groups of four or five with a clover-leaf pattern. It has been presumed by Palade (1956) and others, that these granules contain RNA (ribo-nucleic acid). Close to the nucleus there are small mitochondria and a few lamellae and vesicles of the same type as in the Golgi-apparatus. In a previous report (Bergstrand and Bucht 1956) we have described large vesicles, surrounded by a double membrane in the cytoplasma of the endothelial cells in a patient, suffering from a subacute glomerulonephritis. We have also made similar observations in animals (Bergstrand 1957) and have presumed that the vesicles are formed in the epithelial cells also under physiological conditions and are ejected into the blood stream in the capillary. There they