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Histological Structure of the Kidney of Insectivorous Bats

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Abstract: The Kidneys are important organs that regulate the volume and composition of body fluids. On the other hand, some of the diseases that infect bats may also be transmitted to people. The present study was, therefore, undertaken to deal with the histology of the kidneys in bat. The kidneys were covered by a capsule of loose connective tissue. The Bowman's capsule surrounded the glomerulus. The epithelium of the proximal convoluted tubule was simple columnar. The apical surface of this epithelium was covered by a continuous brush border of microvilli. The loop of Henle was not observed in the kidney of bats. The distal convoluted tubule and collecting ducts were lined by simple cuboidal epithelium. The macula densa was present in the kidney of bats.

Key words: Kidney · Bat · Histology · Cortex · Medulla

INTRODUCTION

Kidneys conserve fluid components necessary to maintain homeostasis while ridding the body of metabolic waste products, as well as excess water and electrolytes, in the form of urine. An understanding of the structure of the kidney and especially the interrelationship of the renal tubules and renal vasculature, is essential to appreciate the diverse functions of the kidney [1].

On the other hand, bats (order Chiroptera, suborders Megachiroptera and Microchiroptera) are abundant, diverse and geographically widespread. Rabies and histoplasmosis are the most important public health issues to consider when dealing with bats. Bats provide us with resources, but their important is minimized and many of their populations and species are at risk, even threatened or endangered. Some of their characteristics (food choices, colonial or solitary nature, population structure, ability to fly, seasonal migration and daily movement patterns, topor and hibernation, life span, roosting behaviors, ability to echolocate, virus susceptibility) make them exquisitely hosts of viruses and other disease agents. Detailed information is needed to explain the astonishing variations of their anatomy, their lifestyles, their roles in ecosystems ecology and their importance as reservoir hosts of viruses of proven or potential significance for human and veterinary health [2]. Due to vital function of kidneys and also important role of bats in public health, the present study was, therefore, undertaken to deal with the histology of the kidneys in bats.

MATERIALS AND METHODS

The histological structure of the kidneys was examined in 3 adult insectivorous bats. They euthanasia and kidneys were removed. The samples were flushed with normal saline and were fixed in 10% buffer formaline for 72 hr. Tissue samples were then dehydrated, cleared and embedded in paraffin. Sections (5 µm) were stained with Haematoxylin & Eosin and Periodic Acid Schiff-Alcian blue for the muco-substances. The stained sections were observed by light microscopy.

RESULTS

The kidneys of the bats were smooth and beanlike (Fig. 1). They were coverd by capsule of loose collagenous tissue (Fig. 5). Each kidney was consisted an outer, dark cortex and an inner, lighter-colored medulla (Fig, 1). The renal corpuscle, found in the cortical labyrinth. It was spherical and varied in size. The renal corpuscle was composed of the glomerulus and the glomerular capsule. The glomrular capsule (Bowman's capsule) surrounded the glomerulus and composed of visceral and parietal layers. At the vascular pole of the

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Fig. 1: The shape of the kidney of an insectivorous bat. Cortex (COR), medulla (MED) (Haematoxylin & Eosin × 64)

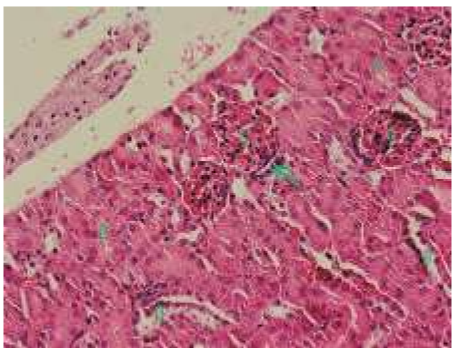

Fig. 2: Showing the cortex of the kidney of bat. Proximal convoluted tubule (P); distal convoluted tubule (D); glomerulus (G), macula densa (arrow) (Haematoxylin & Eosin × 640)

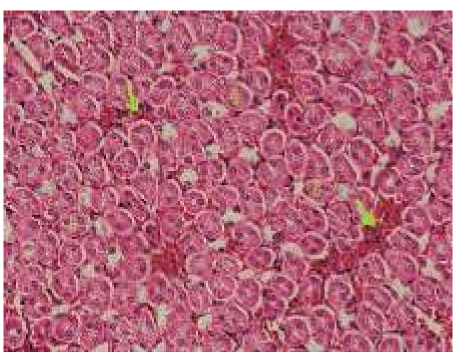

Fig. 3: Photomicrograph of the medulla of the kidney of bat. Collecting ducts (C), capillary (arrow) (Haematoxylin & Eosin × 640)

renal corpuscle, the visceral layer of the glomerular capsule becomes continuous with the parietal layer. The parietal layer was composed of a simple squamus epithelium. The lumen created between the two epithelial

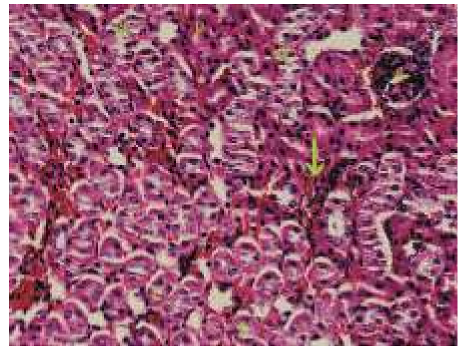

Fig. 4: Photomicrograph showing collecting duct (C); cortical collecting tubule (CC); proximal convoluted tubule (P); glomerulus (G), capillary (arrow) (Haematoxylin & Eosin × 640).

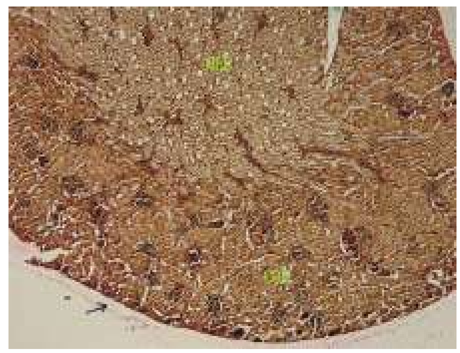

Fig. 5: Showing the kidney of bat. Cortex (COR); medulla (MED), capsule (arrow) (PAS-Alcian blue staining ×160)

layers is called the urinary space. At the urinary pole of the renal corpuscle, opposite the vascular pole, the glomrular capsule opens into the proximal convoluted tubule (Fig. 2). The proximal convoluted tubule began at the urinary pole of the renal corpuscle with an abrupt change in epithelium from the simple squamous epithelium to a simple columnar epithelium. The apical surface of this epithelium was covered by a continuous brush border of microvilli. The microvilli were not covered by an, PAS-positive cell coat (Fig. 5). The loop of Henle was not observed in the kidney of the bats. Therefore, the nephrons of bats are loopess (reptilian) type. The proximal convoluted tubule was continued with the distal convoluted tubule.The distal convoluted tubule was lined by simple cuboidal epithelium. The nucleus was located in the apical part of the cell. The macula densa was found in the kidney of bats (Fig. 2). The medullary rays were consisted of cortical collecting tubules (Fig. 4). The collecting duct was lined with cuboidal epithelium. The medulla of each kidney was formed mainely from collecting ducts. The borders between the cells of the collecting ducts of bats were not easily distinguished. Also, their cytoplasm was not so much pale (Fig. 3). In addition, the collecting ducts did not positive reaction in Alcian blue-PAS staining (Fig. 5).

DISCUSSION

The kidney has diverse roles in maintaining homeostasis. In mammals the two kidneys receive approximately 25% of the cardiac output. The kidney filters the blood and thereby excretes metabolic waste, while retrieving the filtered substances that are needed by the body, including low-molecular-weight proteins, water and electrolytes. The kidneys respond to water, electrolyte and acid-base disturbances by specifically altering the rate of reabsorption or secretion of these substances. The kidneys also produce hormones that regulate systemic blood pressure and red blood cell production. The nephron is the functional unit of the kidney and varies greatly in structure amongst different vertebrates [3]. Amphibians and reptiles, which are able only to produce isosmotic or hyposmotic urine, do not have a loop of Henle [4]. This characteristic is the same as bats, whereas birds and mammals produce a hypertonic urine due to the presence of a loop of Henle [5,6]. In birds, the cortical (reptilian) nephrons do not contain a loop of Henle and are referred to as loopless nephrons [7]. The other nephron is the less numerous medullary (mammalian) type. It has a loop of Henle, which extends into the medulla. Cortical nephrons are arranged radially around central (interalobular) veins of the cortex [8]. In mammals, all nephrons contain a loop of Henle, but some are long and some are short [9].

The first step in renal function is filtration of the blood. Filtration takes place in glomerulus which is a network of capillaries that retains cellular components and medium-to high-molecular-weight proteins within the vascular while extruding a fluid nearly identical to plasma in its electrolyte and water composition. This fluid is the glomerular filtrate; the process of its formation is glomerular filtration. The bulk of the ultrafiltrate formed in the glomerulus must be reabsorbed by the renal tubules rather than excreted in the urine. The rate of reabsorption and secretion of filtered substances varies among segments of the renal tubule. In general, the proximal convoluted tubule reabsorbs more of the ultrafiltrate than other tubule segments, at least 60% of most filtered substances [3]. The proximal convoluted tubules are longer than the distal convoluted tubules and comprise the major portion of the cortex [8].

After leaving the proximal convoluted tubule, the filtrate passes into the loop of Henle that travels from the cortex into the medulla and out again. The loop of Henle is responsible for further reabsorption of water from the filtrate, as well as sodium and chloride ions. The counter-current exchange occurs due to the very close association of the ascending and descending limbs. On leaving the loop of Henle, the tubular fluid has had the majority of some substance reabsorbed, e.g. glucose, water and sodium ions. The distal convoluted tubule carries out selective absorption and active secretion of certain compound to adjust the composition of the capillary network under the control of the hormone aldosterone. Secretion of aldosterone causes on increase in the amount of sodium ions reabsorbed and a consequent decrease in their excretion in urine. Calcium ions are also reabsorbed under the regulation of the hormones calcitriol and parathyroid hormone [10].

The filtrate from several nephrons passes into a collecting duct. It is here that the final adjustments to the composition and volume of urine take place. Aldosterone continue to have its effect on proximal regions of the collecting duct that lie within the renal cortex, while ADH affects the permeability of the walls of both the distal convoluted tubule and the collecting duct to water. Secretion of ADH causes the walls to become permeable and consequently water moves from the tubule into the peritubular fluid. The resultant urine produced in concentrated (hypertonic) [10]. Histologically, the collecting duct in birds is contained numerous mucopolysaccharide vesicles. These vesicles stain positive with Alcian blue and PAS staining [11]. The cells of the collecting duct have pale cytoplasm. Also, the borders between the cells are easily distinguished because of the relatively straight, lateral cell membranes [1].

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