RENAL EXCRETION

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Contents

Summary

Kidneys regulate the water and ion balance and take care of the excretion of metabolic wastes. The nephron, the functional unit of the kidney, is composed of a glomerulus and a tubular system. The glomerulus consists of a compact tuft of interconnected capillary loops and a balloon-like hollow capsule (Bowman's capsule) into which the capillary tuft protrudes. The renal tubule is composed of a single layer of epithelial cells resting on a basement membrane. The special vascular system of the kidney is in intimate structural and functional relationship to the tubular system, specifically adapted for filtration and reabsorption processes. The renal interstitium, which itself has a complex structure with changing composition from cortex to the tip of the medulla, complements the functions of the vessels and the tubules. The outcome of the proper functioning of the kidneys is the production of about 1.5 liters of urine per day. Urine contains metabolic waste products of the cells, ions and some cellular elements which must be disposed of outside the body.

1. Introduction

Kidneys have a central role in human wellbeing, as in all terrestrial animals. The internal milieu affects all the cells. Organisms living in aquatic and especially in marine surroundings have no problems concerning water availability. In the marine

environment there are no problems in the availability of most important ions, which the cells need. In aquatic organisms the release of wastes is also simple compared to the terrestrial animals. Adult humans can survive only about three days without water intake, but young children are even more sensitive. Humans lose some water through their skin even without sweating. The non-volatile wastes are cleaned from the body mostly by the kidneys, and this requires a certain amount of water, which thus is lost. Some animals have, however, great capabilities to recapture the water and are able to survive with very small amounts of water, which they get from their food without drinking any fluids.

The cleaning of the blood by the kidneys requires effective circulation. The renal arteries are wide, and some one fifth of the cardiac output passes through the kidneys and the volume of the primary urine (glomerular filtrate) produced per day, exceeds the human bodyweight 2-3 times. The minimal urine volume is, however, some 500 ml, which indicates very effective recapturing of water and also many valuable ions and other solutes. Thus the energy consumption of the kidneys is remarkable. Kidneys effectively regulate their own blood circulation and also affect the general circulation as well as the blood pressure, which Dr. Robert Tigerstedt demonstrated more than a century ago by discovering renin (see *Physiology and Maintenance*).

The kidneys have great reserve capacity, and some humans may manage to live through their whole life without knowing that one of their kidneys is not functioning properly. Infections, hypertension and metabolic diseases like diabetes mellitus can, however, greatly affect the kidneys and stop their functioning. Poorly functioning kidneys can be helped with dialysis, and the transplantation of kidneys was mastered several decades ago. Kidney transplantion can make a real change in the life quality of patients whose kidneys have failed to function properly. The success of renal transplantation depends on many factors including immunological compatibility. In this respect, identical twins make the best donors. International networks help in securing human kidneys from accident victims (cadavers). The chance of rejection of transplanted kidneys can be greatly reduced by proper diagnostic precautions and medications. In many countries people are able to donate their bodies for humanitarian purposes (organ transplantation).

2. Functional Anatomy and Histology of the Kidneys

The kidneys are paired organs, which lie outside the peritoneal cavity in the posterior abdominal wall, one on each side of the vertebral column (see Figure 1). The renal vessels, lymphatics, nerves and the ureter pass through the *hilum* of the kidney. The kidney is composed of cortical and medullary parts. The medulla is composed of a number of renal *pyramids.* Their apices project into the minor calyxes which then drain into the major calyxes and finally into the renal pelvis. Each pyramid of the medulla, topped by a region of renal cortex, forms a single lobe (see Figure 2).

3. Nephron

The nephron is the functional unit of kidneys. Each human kidney contains about 500 000 to 1 500 000 of them. Each nephron consists of a filtering component, called

the glomerulus, and the processing unit, the tubule, which extends out from the glomerulus.

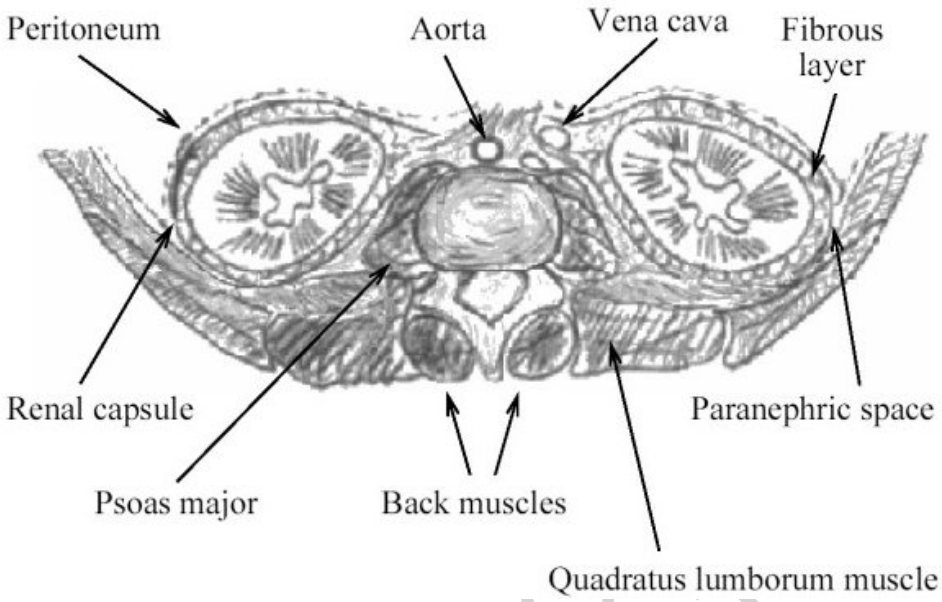

Figure 1. The position of the kidneys in the abdomen. Horizontal section.
Source: *Textbook of Nephrology* edited By Rosivall L., Farsang Cs., Kiss E., Medintel Press, Budapest, 2003, in press. Used by permission.

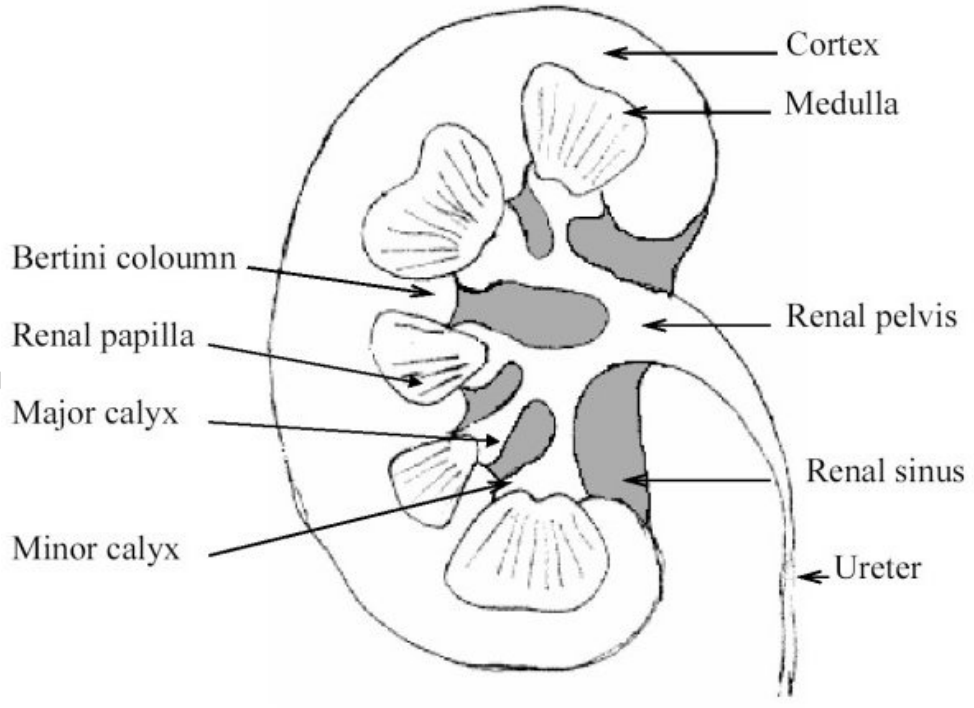

Figure 2. The structure of the kidney. Frontal section.
Source: *Textbook of Nephrology* edited By Rosivall L., Farsang Cs., Kiss E., Medintel Press, Budapest, 2003, in press. Used by permission.

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Biographical Sketches

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