
# Features Of Kidneys Exposed to Various Factors


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**ABSTRACT**

The kidney refers to organs with an intense functional load throughout a person's life and is a complex organ that functions to filter waste from the blood through the production of urine, which occupies an increasingly important place in modern research. The kidneys also perform various other vital functions, including supporting homeostasis, regulating blood pressure, osmotic pressure and acid-base balance. Reviews of their results are certainly important for the development of ideas about the kidney and its significance for science. It is proved that in the kidneys of adults and fetuses during implementation, when exposed to various factors at the level of tissues, interstitial relationships, nephron divisions and between different types of nephrons (subcapsular and juxtamedullary), morphological changes are formed that characterize "urgent adaptation". For the first time, from the standpoint of the doctrine of the impact of various factors, a characterization of changes in the kidneys under specific pathological processes and in conditions of increased functional loads is given, morphological criteria for classifying structural manifestations of nephron responses to successive phases of adaptation are proposed. But deciphering the relationship of the kidney with biostimulants is much more promising for research when searching for the elimination of the above factors.

**Keywords:** Homeostasis, osmotic pressure, acid-base balance, nephron.

**Relevance.** In humans, 170 liters of glomerular filtrate are formed from 1,700 liters of blood that passes through the glomerular capillaries of both kidneys in 24 hours, from which 168 liters are absorbed back, and about 1.5 liters enter the ureters, making up the daily amount of urine.

The human kidney is multi-lobed, contains from 8 to 18 lobes. The outside of the kidney is covered with a connective tissue capsule, and the front is covered with a serous membrane.

There are external cortical and internal medulla. In the kidneys, radially located straight tubules of the medulla are located in the renal pyramids, two or three pyramids can combine to form a renal papilla. And between the pyramids descend columns of cortical matter - Bertini columns. The most characteristic structures of the cortical substance are renal corpuscles (consisting of glomeruli of capillaries and glomerular capsules), as well as convoluted tubules.

The renal pyramid, divided by renal columns, together with the cortical substance located above its base, makes up the renal lobe.

The nephron is a structural and functional unit of the kidney, there are 1.3 million nephrons in each kidney, the length of the tubules of all nephrons of the kidney is 120 km (the length of the tubules of 1 nephron is 50-55 mm). The composition of the nephron includes: glomerular capsule, proximal convoluted canaliculus, Henle loop and distal convoluted canaliculus.

And the nephron capsule (diameter 150-250 microns) is formed by two leaves. The outer leaf (parietal) is formed by a flat epithelium, the inner - visceral leaf is formed by special cells -podocytes. These cells have a nuclear part of the cytoplasm, from which large processes - cytotrabecules - depart. Small processes - cytopodia - depart from the cytotrabecules. Filtration slits lie between the cytopodia. There is a Bowman's space between the capsule leaves, into which the renal filtrate enters. The bearing artery enters the capsule and, breaking up into capillaries, forms a renal glomerulus. The outflow artery has a diameter two times smaller than the bringing one, which creates increased pressure in the capillaries - 70-90 mm / Hg. and ensures the release of blood plasma into the Bowman space.

In the nephron, the proximal convoluted tubule is a tube with a diameter of 60 microns and a length of about 14 mm. The tubule is lined with a single-layer cylindrical epithelium, on the apical surface of the cells of which microvilli form a brush border. In the basal part of the cells, basal striation is visible, formed by the ordered arrangement of mitochondria between the folds of the basal plasmolemma. In the proximal convoluted tubule, 85% of water, Na, Ca, glucose, amino acids, and phosphates are absorbed. The suction process is active with energy consumption. Protein molecules are absorbed by pinocytosis. The same cells secrete dyes and penicillin into the urine.

The nephron loop of Henle has ascending and descending parts. The diameter of the descending part is 15 microns. The epithelium of the tubule is single-layered flat, there are no microvilli, there are single outgrowths. The ascending part of the Henle loop is lined with cubic epithelium, has a diameter of 35 microns, and a length of 9 microns. There is no brush border, but the basal striation is well developed. In the tubules of the Henle loop, water, Na+ and Cl ions are absorbed due to the difference in osmotic pressure (Na-Ka pump). And the distal tubule has a length of 4.6 - 5.2 mm, the diameter is 20-50 microns. The epithelium has the structure of the ascending part of the Henle loop. In this area, water is absorbed under the action of ADH synthesized in the hypothalamus (large-cell supraoptic nucleus).

At the place where the distal tubule comes into contact with the bearing glomerular artery, a juxtaglomerular complex is formed, which consists of two parts. There is a dense spot in the distal tubule here - the nuclei of epithelial cells lie very tightly, because the cells are narrow. In the middle shell of the bearing artery, smooth muscle cells are replaced by near-tubular cells - these are polygonal cells containing coarse grain. The perilobular cells are in close contact with the inner lining of the artery and with the epithelial cells of the dense spot. In the interval between the bringing and taking out arteries, there is an islet of mesangia.

A decrease in the volume of blood or tissue fluid is perceived by afferent arterioles acting as baroreceptors, and changes in the concentration of Na+ ions are recorded by a dense spot. At the same time, the tubule cells synthesize renin, under the action of which the plasma angiotensinogen passes into angiotensin I, which in the lungs turns into angiotensin II, which is a strong vasoconstrictor (hypertensive) hormone.

The kidneys play a major role in accelerating the removal of radionuclides from the body, being an excellent passive filter that cleanses the blood of toxins and decay products. They produce urine to accelerate the removal of poisons from the body, including radionuclides, regulate the composition of body fluids, maintain the acid-base balance of the blood, affecting sensitivity to radiation. Factors that overload the kidneys are stress, increased meat content in the diet, slagging, etc. In any case, a violation of the kidneys increases the load on other excretory organs. If slags, decay products, radionuclides are not removed with urine, then they are excreted through the pores of the skin with sweat. Normal kidney function contributes to the elimination of radionuclides from the body.

The substances that improve kidney function include magnesium, calcium, vitamin C. The most unique product that gives the kidneys almost everything they need is buckwheat. The slagging of the kidneys is removed by a special technique.

Any biological system is open. The influence of exogenous factors (afferent impulses) on the biosystem is manifested by certain reactive changes, and the heterogeneity of its structures ensures the performance of specialized functions [14,32]. At all stages of ontogenesis, the body constantly experiences environmental influences, which in some cases determine its physiological states, in others - to maintain the body's functions at a vital level, external factors cause an increase in the activity of compensatory adaptive mechanisms. Such needs may arise under the influence of various physical or psychotropic stressors that can cause the development of a stress reaction [8,12,29].

The insufficiency of the body's adaptation processes leads to a different form of its vital activity, which is considered as a disease [11]. However, during the formation of adaptive reactions, it is sometimes difficult to identify the inconsistency of the mechanisms providing them, which probably makes it difficult to draw a clear boundary between the physiological norm and pathology [52], especially since the parameters of the latter are very variable for two separate individuals.

The kidney performs a large number of functions. It participates in almost all types of metabolism and ensures the maintenance of homeostasis of the body. Thus, the kidney is an important link in the formation of adaptive reactions to various external influences or in the event of a disease from other organs and systems [36,43].

According to the literature, kidney diseases account for about 5.5-6.0% of the total incidence. However, more thorough screening studies indicate kidney damage in approximately 7-10% of the adult population. Such an underestimated diagnosis of renal diseases is explained by their "non-manifestation" and "unidentification" in the early preclinical phases of the disease [5].

Acute and chronic glomerulonephritis, nephrotic syndrome of various etiologies, and chronic pyelonephritis can be attributed to diseases with a large share of erroneous diagnoses [64,18]. The reason for such errors in the formulation of the diagnosis, as the author points out, is, firstly, a certain similarity in the manifestations of a number of kidney diseases; secondly, the lack of a clear correlation between clinical and functional indicators and morphological changes of the organ. Often, fairly moderate structural disorders of the kidneys correspond to the obvious clinical picture of the disease. At the same time, significant morphological changes are manifested by weakly expressed laboratory and clinical data, which is obviously associated with the mobilization of the reserve capabilities of the organ. Often, the latent pathology of the stoves of the postnatal period is the result of violations of their intrauterine development [33,69].

In the course of differential diagnosis of renal diseases, despite the widespread introduction of numerous research methods used in clinical nephrology, the number of erroneous diagnoses remains quite high. Most of these studies concern the excretory function of the kidneys [14].

Although a considerable period of time has passed since the publication of the cited works, these problems of compensation and redundancy of functions in renal diseases have remained relevant in the last decade [22,47,75].

The development of reactive changes in the kidney, like any other organ, is a stress reaction. Defining stress, G. Selye characterized it "as a state of nonspecific stress in living matter, which is manifested by real morphological changes in various organs" [66].

Using models of experimental pathology of the kidneys and the direct action of pharmacological drugs on them based on the provisions of G.Selye on stress as a nonspecific response of the body and the stage formation of the "adaptation syndrome", it is possible to find out the causes of possible morpho-functional inconsistencies of the kidneys in the early periods of the formation of responses of organ structures [51,68].

In a comparative study of mammalian kidneys with Masuga glomerulonephritis, pyelonephritis, after the administration of diuretics (acetazolamide and mercuzal) and metanephros of 21-day-old fetuses, it was shown that along with specific morphological changes characterizing the development of a specific pathology, there are nonspecific structural changes underlying the common manifestations of stress and a specific disease, realized in similar functional changes of the organ with specific nosologies.

It has been proved that morphological changes characterizing "urgent adaptation" are formed in the kidneys of adults and fetuses during the implementation of stress at the level of tissues, interstitial relationships, departments of nephrons and between different types of nephrons (subcapsular and juxtamedullary). They are represented by the following structural manifestations: signs of increased filtration process, changes in blood filling of vessels in different areas of the kidney, the formation of similar tubulo-interstitial reactions and disorders of the epithelial lining of the tubules of the nephron.

For the first time, from the standpoint of the doctrine of stress, the characteristics of kidney changes in specific pathological processes and under conditions of increased functional loads are given, morphological criteria for attributing structural manifestations of nephron responses to successive phases of adaptation are proposed.

Morphological signs of the development of their adaptation and disadaptation of nephrons are described, which are represented by the following morphological and functional states: prenosological, increased functional tension, development of disadaptation and disruption of adaptation. In renal diseases, the quantitative ratios of nephrons of various morpho-functional states in the kidney, as a biological system, reflect compensated and decompensated states that may cause the appearance of certain clinical and functional manifestations common to various nosologies of renal pathology.

The obtained data on the structural transformations of the kidney during ontogenesis revealed the formation of similar morphological manifestations of reactive changes in the epithelium of nephrons, intercanular connective tissue, vascular-tissue relationships and microcirculatory bed, both mediated by experimental pathology of the organ, and after functional loading on individual structural and functional units of the kidney with pharmacological preparations.

In the initial periods of the development of glomerulonephritis Masugi and pyelonephritis, destructive-inflammatory and proliferative-regenerative processes dominate, the first of which reflect the development of the initial stage of imperfect "urgent" adaptation of the organ, and the second are implemented by the same mechanisms that ensure the performance of increased functional load with the introduction of diuretics.

In kidney diseases, the maintenance of some of their functional indicators at levels close to normal conditions can be provided by mechanisms for reserving functions implemented by structural transformations that characterize the kidney as a multilevel self-regulating biological system with high reserve capabilities. Within this biosystem, the formation of a non-specific part of adaptive reactions is associated with responding to specific etiological factors as stressors. Depending on the nature of the stress reaction and its duration, either adaptation or dysadaptation occurs - a condition associated with significant damage to the nephrons and other organ structures of the kidney. Such disorders can be compensated for a certain time by increasing the functional activity of the preserved structural units of the organ, however, an increase in the duration of this condition causes functional decompensation, which is based on pronounced damage to the renal parenchyma and stroma. A significant role in the formation of the mechanisms of adaptation of the kidney is played by changes in the ratio of the absolute number of different morphofunctional types of nephrons. This is reflected by the manifestation of the corresponding adaptive processes at the tissue and cellular levels of the organ organization.

The studied structural manifestations of nonspecific general pathological changes in nephrons and interstitial kidney tissue allow us to explain the existence of some similar clinical and laboratory manifestations of a number of kidney diseases that occur as structural and functional manifestations of the formation of an adaptive organ response at the tissue and cellular levels.

Individual inconsistencies between the functional parameters of the kidney and its structural changes occurring with a particular pathology of the organ are the result of the development of adaptive reactions of the kidney as a whole. Its adaptive processes are carried out not only due to the specified tissue mechanisms of the organ, but also due to changes in the ratios of morphofunctionally specific subcapsular and juxtamedullary nephrons.

The revealed features of the formation of adaptive reactions of tissue-cellular and organ levels in the development of kidney diseases indicate a wide variability of functional parameters and structural characteristics of the kidneys. These structural and functional features of the development of the adaptive process should be taken into account in the clinical practice of doctors of relevant specialties. They can be useful in the differential diagnosis of certain renal and extrarenal pathology, especially in the initial stages or in cases of latent diseases.

Analysis of the data obtained showed that already on the first day of the experiment, ion-regulating mechanisms begin to react in response to insufficient intake of sodium into the body. It turned out that the background indicators of sodium excretion and its excreted fraction in this series of experiments were significantly lower compared to similar indicators in normal and high-sodium diets.

It should be noted that the differences obtained not only persisted throughout the experiment, but also increased by 28 days. However, after the introduction of an aqueous load on the 1st day of the experiment, the excretion of sodium by the kidneys under conditions of a deficiency of its intake into the body differed little from that with a normal sodium diet, which can probably be explained by an increase in urinary excretion of cation under conditions of aqueous diuresis [30.47]. On the next day of the experiment, the level of sodium excretion and its excreted fraction was significantly lower than the corresponding indicators for both normal and high-sodium diets.

Unlike a low-sodium diet, in response to excessive intake of sodium into the body, the mechanisms of ion regulation do not begin to react immediately, but only on the 3rd day of the experiment. It was noted that the background level of sodium excretion and its excreted fraction was significantly higher than similar indicators of diets with normal and low sodium content, and these differences were more pronounced in the dynamics of the experiment. After the introduction of a water load for 1 day, there were no significant differences in the indicators for different sodium diets, which was probably also due to the lack of full adaptation of the body to the food diet. However, on the 3rd day of the experiment, the excretion of sodium by the kidneys of animals on a high-sodium diet was significantly higher compared to conventional and low-sodium diets, which was an adequate reaction of the body to a high intake of this element with food. It should be noted that the differences in the excretion of sodium and its excreted fraction, depending on the content of cation in food, were more clearly manifested in background samples than after loading with water. This is probably due to the inclusion of volumetric mechanisms, as well as the leaching of sodium in the urine.

In response to the different intake of sodium into the body, not only ion-regulating, but also osmoregulatory mechanisms begin to react. It was found that under the conditions of a low-sodium diet, the background level of osmotic plasma purification for 1 day was lower than with normal and high-sodium diets, whereas during the subsequent experiment no significant differences were found from a diet with a normal sodium content. After the introduction of the water load, no clear dynamics were revealed, however, it was recorded that by the 28th day osmotic plasma purification in the experiment with a low-sodium diet was higher compared to a diet with a normal sodium content; in conditions of low sodium intake into the body on the 1st day of the experiment, in response to a decrease in the background level of osmotic plasma purification, the level of osmotic free water release increased relative to the indicators of a normal and high-sodium diet, which indicated the presence of hypoosmia. However, the effect did not persist in the future, and the level of osmotic excretion of free water, as well as osmotic purification of plasma, did not differ from that of a normal sodium diet. After the introduction of a water load, the release of osmotic free water was lower than with a normal diet with sodium during almost the entire experiment.

From the above data, it is clear that when exposed to vibration, cell metabolism is disrupted, a state of metabolic acidosis and oxygen starvation occurs. Even, it would seem, with such a slight vibration effect, as from the 9th to the 11th day of pregnancy and a one-time exposure of 1 hour, structural changes in the cortex of the kidney of the mother and fetus are already registered. In pregnant females, the specific density of capsule lumen increases, although in all other experimental groups, the density of capsule lumen increases. The lumen of the capsules is the place where the primary ultrafiltrate initially enters, which then descends through the mouth and lower along the lumen of the proximal section. But the lumen of the capsule itself does not change. It is clear that the increase in the lumen of the capsule can only be due to an increase in the amount of its contents - the primary ultrafiltrate. Filtration of blood plasma in the renal glomeruli is carried out due to high hydrostatic pressure, which determines the passage of a significant part of the liquid contents of blood capillaries through filtration slits into the lumen of the renal corpuscle capsule [4,24,76]. The increase in the amount of primary urine, that is, the acceleration of the filtration process, can theoretically be due to several reasons: due to its "excessive" formation as a result of the acceleration of podocyte activity, which, in turn, can occur with accelerated blood flow through the renal parenchyma and (or) simultaneous slowing of the passage of primary urine through the underlying nephron. Which, in turn, can occur with an increase in blood pressure, as well as an increase in pressure inside the glomerular capillaries. Either as a result of a violation of ultrafiltrate evacuation with narrowing of the mouth of the proximal department or the proximal department itself, which may occur as a result of interstitial inflammation [24,53]. Since, in our study, a decrease in the volume density of the lumen of the proximal department was not found, and there is no data in the literature on possible narrowing of the mouth of the proximal department, we are inclined to believe that the growth of the lumen of the Shumlyansky-Bowman capsule in the kidneys of females when exposed to vibration from the 9th to the 11th day of pregnancy occurs as a result of compensatory acceleration of blood passage and the work of podocytes, as well as an increase in pressure inside the glomerular capillaries (blood stasis). This point of view is supported by an increase in the volume of circulating blood and an increase in the blood flow rate in all pregnant women [16,37], which ensures adequate functioning of the mother-fetus system.

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