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Sources of Venous Blood Supply of Kidneys in Chicken of Haysex White Breed

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Abstract:

As a result of our studies, it has been found that blood from pelvic extremities in chicken flows along the right and left external iliac veins into the pelvic cavity. The caudal portal vein of the kidney branches from it in the caudal direction - from cranial part of kidneys. The caudal portal vein collects blood from middle and caudal parts of the kidney. The caudal portal vein, slightly bending in the caudomedial direction, joins the caudal portal vein from the opposite side. Coccygeal mesenteric vein branches from junctions of these veins. The right and left renal veins when joining together with an acute angle flow into the common iliac vein, which in turn enters caudal vena cava. Intraorgan veins of the kidney are divided into interlobular, perilobular, intralobular veins and capillaries. Venous blood from kidneys flows by three different ways. The first way is carried out by the hepatic veins from the midst and caudal parts of kidney. Firstly, these veins flow into the common iliac vein, and then into the caudal part of vena cava. The second way of outflow is carried out through the coccygeal mesenteric vein in the liver. The third way is carried out along the right and left cranial anterior portal veins from the anterior part of the kidney into the vertebral venous canal. The research aim was to study intraorgan branching of veins of the kidneys in chicken of Haysex White breed. Objectives were as follows: describe sources of venous vascularization of the kidneys in chicken of Haysex White breed; conduct morphometric analysis of renal veins in chicken of Haysex White breed.

Keywords: kidneys, chicken, renal veins, valves, capillaries.

INTRODUCTION

The variety of bird species that have evolved during their evolution is the result of complex interaction of the organism of these vertebrates with environmental factors [1, 2]. Enhanced metabolism plays a leading role among these factors. It affects features of the structure of their kidneys and sources of arterial and venous blood flow [3-5].

Venous system of kidneys of birds which originated from the reptilian ancestors differs significantly from that of mammals. It is more complex and universal. It has double system of portal veins in the kidneys and supply mechanism of the urine formation.

The urinary system is one of the most important systems of the organism participating in metabolic processes that determine a high level of metabolism and the release of harmful substances from it. And the intensity of urination depends on many factors: special structure of kidneys, the absence of the bladder and pelvis, intensive vascularization of kidneys, and the presence of venous vessels in their portal system.

Kidney functions are numerous and very diverse. Kidneys not only excrete urine, but also regulate chemical composition of blood and the amount of water in the body. Concentration of salts dissolved in the liquid medium of the body plays a big role. Homeostasis of the internal environment of organisms is constant, and is achieved by blood filtration through the kidneys and back absorption (diosorption) into the blood of the components necessary to the body, which normally cannot be excreted. Unnecessary body substances are secreted with kidneys and transformed into the urine. In this regard, of great interest is the study of urinary organs, which have significant differences from mammals.

The study of kidneys for veterinary specialists in chickens, ducks and geese also has a particular interest, as they have large agricultural purpose, due to the wide distribution and large number of species. However, for veterinary practice it is important to have deep understanding and an objective assessment of the urinary system of birds that are impossible without fundamental knowledge of their structure and function.

In the special literature on the anatomy of renal venous system of birds, there are individual papers [3-8], in which authors confine themselves to describe main trunk veins of the pelvic cavity; data on the venous outflow from kidneys are few and contradictory.

MATERIALS AND METHODS

Subjects of the study were carcasses of adult chickens of Haysex White breed at the age of 160 days in the amount of 10 pieces of both sexes. The birds were clinically healthy, had normal development, correct body form and good fatness. The Belokryl self-hardening plastic was used for the production of angio osteo topical preparations of renal venous system. Oil paints were added to the monomer in order to make the desired color. After filling the vessels, carcasses were placed for 3 days in 15% solution of caustic soda. The resulting corrosion model was washed with water, dried, and then the details of preparations were measured with an ocular microruler, followed by statistical processing of the obtained material.

RESULTS

As a result of the studies, it has been found that in the chicken, blood from the pelvic limbs flows along the right and left external iliac veins, having a diameter of 0.53±0.04 (male) and 0.43±0.04 mm (female). At the same time, blood flows along the sciatic vein, which is located behind the external iliac vein at the distance of 17.4 mm (Table 1).

Venous system of the pelvic region has a closed annular shape formed by the union of the right and left caudal portal veins of the kidneys in the posterior part, and in the anterior part - by the right and left cranial portal veins of kidneys. Primary urine is formed in kidneys due to vascular glomeruli of the afferent and efferent arterial vessels. Renal veins collect venous blood filtered through the parenchyma of the kidney from the middle and caudal parts. From the cranial part of the kidneys, blood is collected by the cranial portal vein and flows into the vertebral venous sinus.

Intraorgan vessels that originate from the system of the cranial and caudal portal veins of the kidneys and renal veins in the form of segments branch out into the cortical and partly in the brain zone of the kidneys in accordance with the configuration and structure of the organ. They flow to the right kidney in the amount of two to three, and in the left kidney in the amount of four to five pieces. The direction of intraorganic venous blood flow of the renal vein completely repeats branching of the system of portal veins of the kidney, and is located from their ventral surface. The direction of renal veins, which branch out into the cranial and caudal parts of the kidney in three-dimensional dimension, has been noted. This can be observed in the dorsal, lateral and medial directions by a trunk type, filling the whole parenchyma of kidneys. In the more flattened middle part of the kidney, the

vessels diverge only in the lateral and medial directions. The kidney inside consists of individual lobules of pyramidal shape. Intraorganic veins are divided into interlobular, perilobular, intralobular veins and capillaries. In chicken, perilobular veins and venous capillaries have tree-like shape. Cortical zones of the kidney are located along the perimeter, closer to its lateral margin. They collect venous blood from the renal vein, and through it the blood is directed to the common iliac vein. At the same time, in-and-out system of venous capillaries is formed. Liquid, mineral substances and acids are absorbed through this system into the renal parenchyma, and then concentrated urine is collected by the ureteral capillaries located parallel to the secondary and primary branches in the ureter. On the ureter, concentrated urine is excreted by peristaltic contractions of the ureter in the form of a mushy structure in the middle part of the urodeum (fig 1).

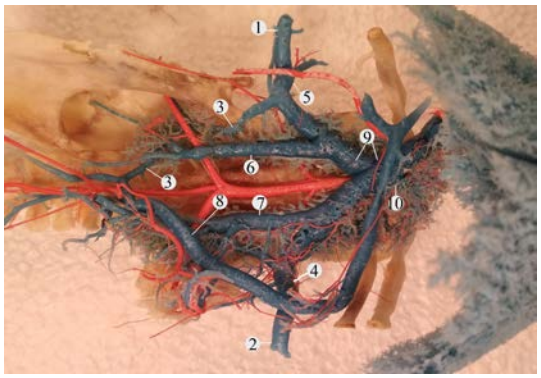

Fig. 1. Sources of venous blood circulation of the kidneys in the chicken of Haysex White breed from the ventral surface (photo from the corrosion preparation): 1 - right external iliac vein; 2 - left external iliac vein; 3 - right portal hepatic vein; 4 - left common iliac vein; 5 - right common iliac vein; 6 - right renal vein; 7 - left renal vein; 8 - coccygeal mesenteric vein; 9 - caudal hollow vein; 10 - left portal vein of the kidney.

Table 1. The indices of the diameter of the veins of the kidneys in the chicken of Haysex White breed.

Indicators* M±Δm Lim min-max	Floor	Type of birds	
		Chicken of Haysex White breed	
		right	left
Caudal hollow vein	male	0.92±0.02 0.89-0.93	
	female	0.90±0.03 0.88-0.91	
External iliac vein	male	0.51±0.04 0.50-0.52	0.43±0.04 0.41-0.44
	female	0.50±0.01 0.48-0.51	0.40±0.01 0.39-0.42
Internal iliac vein	male	0.63±0.02 0.61-0.64	0.52±0.01 0.50-0.53
	female	0.61±0.01 0.60-0.62	0.58±0.01 0.57-0.59
Renal vein	male	0.35±0.02 0.34-0.36	0.31±0.03 0.30-0.32
	female	0.31±0.01 0.28-0.30	0.29±0.01 0.27-0.30
Cranial portal vein of the kidney	male	0.19±0.02 0.18-0.17	0.18±0.04 0.17-0.19
	female	0.17±0.03 0.16-0.18	0.16±0.03 0.15-0.17
Caudal portal vein of the kidney	male	0.22±0.02 0.20-0.23	0.20±0.01 0.18-0.21
	female	0.20±0.03 0.19-0.21	0.19±0.03 0.18-0.20

Note: * M - arithmetic mean, Δm - error of the arithmetic mean, Lim min - max - minimum and maximum variability, n = 5.

Each external iliac vein enters the pelvic cavity and is guided in the craniomedial way. From it at the distance of 12 cm in the caudal direction, the right caudal portal vein of the kidney with a diameter of 0.22±0.02 mm (male) and 0.20±0.03 mm (female) is separated. The caudal portal vein, slightly bending in the caudomedial direction in the region of the median plane of the sacral bone, joins the caudal portal vein on the other side. From the junction of these veins, the coccygeal mesenteric vein originates at the level of the caudal end of the sacrum and passes cranially. Then it goes to the right side and flows into the right lobe of the liver closer to its intersection. Throughout its whole length the coccygeal mesenteric vein has the same diameter. Pudental and caudal lateral veins flow from the caudal surface into the caudal portal vein.

From the cortical substance, venous blood is collected by capillaries, precapillaries, postcapillaries into the intercostal veins, which are infused with the middle and caudal lobes from the caudal portal vein. Between the renal and the caudal portal vein inside the renal parenchyma, there are arterio-venous anastomoses, through which the filtered blood outflows through the system of tree-like capillaries into the adrenal veins into the renal vein, and then flows into the common iliac vein.

Each renal vein also includes tree-like, segmented interlobular veins, which in our opinion are one of the ways of duplication of arterial branches in the general circulating system of kidneys. Due to this, its reliability of functioning is increased. The presence of such intervenous anastomoses in the morphofunctional relation is of great importance in the uniform distribution of blood in the kidneys. The presence of close morphological relationships among them, and commonality of venous sources indicate their belonging to a single morphological complex and to the same origin. Veins inside kidneys branch out by a trunk type in three planes of the cortical substance of the kidney between connective tissue layers. Due to the double network of venous capillaries, function of the inflow and outflow system in kidneys in birds is realized, which contributes to the effective venous drainage of kidneys with the formation of secondary urine of gritty consistency. Secondary, concentrated urine from kidneys enters the ureter into the urodeum of the middle part of the cloaca.

Right and left renal veins collect venous blood from the middle and caudal parts of the kidney, and fall at the angle of 80° into the external iliac vein, forming a common iliac vein. From the cranial part of the kidney, blood from the external iliac vein is guided along the right and left portal veins, through which blood flows into the vertebral venous sinus. Right and left renal veins, connecting with each other at an acute angle, flow into the common iliac vein, and those which connect at right angles to each other enter a caudal cava vein with a diameter of 0.92±0.02 mm. In the lower third of the caudal side in the common iliac vein of each side, there are right and left renal veins, which carry blood from the caudal and middle parts of each kidney.

Transmural blood flow is more significant in the external iliac and caudal portal renal vein than in the renal vein; therefore, the venous blood is drained through the double capillary system through the renal parenchyma to the renal veins, and is directed to the common iliac vein, which empties into the caudal vena cava.

As a result of the studies, it can be concluded that two systems of the portal veins of the kidneys on the right and left sides are joined together, forming a closed ring. Venous blood flows through the external iliac veins on both sides, enters graft system of the kidneys, causing intravascular pressure, and due to the presence of a group of valves, the blood always flows in one direction. However, anastomoses are formed between renal and portal veins, forming a double network of capillaries, typical for venous vessels of the liver. Due to the double network of venous

capillaries, the blood leaves the kidneys, contributing to the outflow of excess fluid through the parenchyma, participating in its drainage and facilitating outflow into the caudal vena cava. However, it should be taken into account that at the same time part of the blood passes through the coccygeal mesenteric vein into the liver, where it is partially cleared and inactivated.

Renal veins have the same diameter along the entire length of the kidney, and carry out a uniform transportation of venous blood from the middle and caudal parts of the kidneys. It is noted that the venous blood flows simultaneously through three different vessels, but always in the same direction. Perhaps, a powerful vasomotor (vasoconstrictor) mechanism functions inside the two systems of renal portal veins, creating a certain pressure in the place where interlobular veins first enter the renal parenchyma, and then divide into interlobular veins and capillaries. The caudal renal portal vein is a distributing vessel for the middle and caudal lobes of the kidney, and then it is distributed along the peritubular capillaries of their parenchyma. In the cranial portal vein, the blood of their cranial part of the kidneys enters the internal vertebral sinus.

Venous vessels of the kidneys of each side of the chicken are divided into two systems of portal and renal veins, which are morphologically, functionally and genetically interrelated, forming the inflow-outflow mechanism of venous blood flow through the kidneys. Due to the close functional connection of the portal and renal veins in the kidneys due to the transmural pressure formed by the arterial vessels, the venous blood flows uninterruptedly toward the caudal vena cava.

Venous blood from the kidneys can flow in three different ways. The first way is carried out by the renal veins from the middle and caudal parts of the kidney, first flowing into the common iliac vein, and then into the caudal vena cava. The second way of outflow is through the coccygeal mesenteric vein into the liver. The third way is along the right and left cranial anterior portal veins from the anterior part of the kidney into the vertebral venous canal.

CONCLUSIONS

Thus, as a result of our studies, it has been noted that the chicken has three ways of outflow of blood from the kidneys. The first way is through the hepatic veins from the middle and caudal parts of the kidney, flowing into the common iliac vein, and then into the caudal vein. The second way is through the coccygeal mesenteric vein in the liver. The third way is along the right and left cranial portal veins from the anterior part of the kidney into the vertebral venous canal.

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