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Anatomical Features of Kidney Structure in Haysex White Hens

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Abstract

The aim of the research was to study the structure, topography of kidneys in Haysex white hens. The kidneys are paired, whole, parenchymal organs that have an elongated shape and are stretched along the hip bone. On kidneys, there is an insignificant division into three parts: cranial, middle and caudal, differing from each other in different widths, heights, and masses. In the hens (male), the right kidney is longer than the left one by 3.5 mm, and in the hens (female) by 3.1 mm. From the ventromedial surface of each kidney, there is a fraction that has a pear shape on the right kidney, and heart shape - on the left kidney. On the ventral surface of each kidney, there are deep vascular depressions for external iliac and sciatic arteries and veins. From the cranioventral surface, the cranial parts of kidneys touch two adrenals, testes in males, and in females, the right kidney touches the left ovary. The purpose of the study: to study anatomical features, topography and kidney structure in Haysex white hens; to describe the characteristics and topography of kidneys in Haysex white hens; to conduct a morphometric analysis of indicators of kidneys in Haysex white hens.

Keywords: kidney, hen, lobes, ureter, pelvic and renal parts, parenchyma.

INTRODUCTION

In connection with their origin from reptilian ancestors and with adaptation to flight and movement along the ground, birds have many similar features and specific features in the structure of their organs and systems, as confirmed by the studies by D.P. Prothero [1], A. Feduccia [2], P.M. O 'Connor [3].

Birds, like reptiles, have complex sacrum, metatarsal articulation of pelvic limb, a similar structure of kidneys, the absence of bladder and pelvis. But birds, like warm-blooded vertebrates, have high activity, high level of metabolism, directly related to the features of nutrition and accelerated digestion of food.

Intensive metabolism causes certain functional load on urinary organs, which carry out the primary absorption of the liquid part from food and water in the area of the cloaca, and secondary filtration of concentrated urine takes place in the kidneys.

Low-calorie and high-calorie feeding with use of mineral additives [4], fodder stress factors (disruption of mineral metabolism, lack of vitamins) and use of vaccination of birds, can be associated with impaired kidney structure and function.

Kidney functions are numerous and very diverse. Kidneys not only excrete urine but also regulate the chemical composition of blood and water content in the body. They play a big role in the concentration of salts dissolved in the liquid medium of the body. Homeostasis of the internal environment of the body is constant and is achieved as a result of filtration of blood through the kidneys and reverse absorption (diosorption) into the blood of the components needed by the body, which normally cannot be excreted from the body. The secretion of substances unnecessary to the body is carried out through kidneys and their transfer to the composition of mushy urine, which is output immediately through the ureters into the cloaca.

In this regard, of considerable interest is the study of urinary organs, which have significant differences from mammals. The structure and function of urinary organs in birds, in connection with the use of flight, is subject to relief of the entire body weight, which imposes certain and strict requirements on the peculiarities of the structure of not only the pelvic bones, but also to functioning and specialized level of the structure of urinary organs, contributing to their maximum possible functioning with the least use of costs of energy material.

Despite significant advances in the study of structure of internal organs by J.N. Maina [5], J.A. Ruben [6], E.R. Schacher [7], study of lungs by A.N. Makanya [8], study of intra-vascular branching of lung vessels in birds by M. V Pervenetskaya [9], study of respiratory system in domestic birds by L.V. Fomenko [10], study of muscles of shoulder girdle and their blood supply in domestic and some wild bird species by I.G. Tsuskman [11], study of heart and its sources of vascularization in poultry by L.V. Stepanova [12], study of liver structure and its blood supply, only a few studies consider comparative anatomical study of kidneys.

Thus, A.R. Akester [143] performed histological studies of kidneys, urethra and ureters in domestic ducks, R.D. Hodges [14] and V.M. Selyansky [15] – in hen and duck, G. Casotti [16, 17] studied the structure of kidneys in quail, G. Gasotti and K.N. Islam [18] studied the structure and topography of kidneys in hen, C.U. Meteyer [19] studied the arterial and venous renal system in white-headed vulture, R.A. AL-Agele [20] conducted a histological study of kidneys in golden eagle, examined the anatomical structure of pelvic bone, kidneys, their topography and blood supply.

However, most data on structure and topography of kidneys are quite contradictory and presented schematically, this does not allow us to judge the characteristics of breed, species and sex differences.

Of considerable interest for veterinary specialists is the study of kidneys in hen, duck and goose, which have a large agricultural purpose, associated with wide distribution and a large number of livestock and species.

In addition, for veterinary practice, it is important to have a deep understanding and objective assessment of urinary organs in birds, which are impossible without fundamental knowledge of their structure and function.

MATERIALS AND METHODS

The subjects of the study were carcasses of Haysex white adult hens, which were 160 days old, in the amount of 10 pieces of both sexes. The birds were clinically healthy, had normal development, right physique and good fatness. The birds were purchased at the Priirtyshsky poultry farm. For the study of kidneys, the method of ordinary and thin preparation was used, followed by morphometric and statistical processing of the obtained material.

RESULTS

As a result of the study performed, the authors found that the urinary system in birds is divided into urine-forming organs (kidneys) and urinary tract (ureters).

Kidneys – ren – paired, parenchymal organs, dark brown, of irregularly elongated form, located along the hip bone along the sides of its median plane. The kidneys are separated from each other by the ventral crests of lumbar vertebrae and pelvic bones and are located retroperitoneally. In hen, they consist of three different in width, height, structure, mass and structure parts, separated by connecting tissue in the form of thin bridges.

In hen, the kidney, with its parietal surface, deeply penetrates the pancreas of the pelvic bone, completely repeating their contour. By visceral surface, they touch the liver and intestinal loops, forming small depressions. On kidneys, they distinguish dorsal, ventral and medial surfaces, cranial and caudal ends, as well as dorsomedial, dorsoventral and lateral margins.

The gates of kidneys are located from the caudal end of the organ, where the ureter goes out.

Outside, each kidney is surrounded by thin, fibrous connective tissue capsule that does not form stroma. The parenchyma of the kidneys is well-developed, and it clearly traces the presence of small lobules of pyramidal shape with the base directed to the lateral surface of the kidneys, and the tip into the depth of the organ. They are separated from one another by connective tissue.

The thick layer of adipose tissue, forming a fat capsule, surrounds the middle and caudal parts of the kidneys from the side of the abdominal cavity. On ventral and medial surfaces, there are fat deposits that are located covering the kidneys along the entire length. On dorsal surface, no fatty deposits were found. Between the kidneys and organs of the abdominal cavity, diverticula are located, extending from caudal thoracic and abdominal air-carrying sacs.

Dorsal surface of the kidneys is slightly convex, smooth, has the imprint of impressions of renal pits of the pelvic bone. The cranial part of kidneys in the hen from the dorsal surface is even, the middle part is slightly depressed, and on the caudodorsal edge of the caudal part, the hen has four deep impressions that correspond to the pelvic bone relief, forming four small-sized blades.

The cranial part of each kidney is egg-shaped and has the same structure as the dorsal surface. The right cranial part of the kidney is slightly larger, has more developed angles and is located slightly more cranial than the left cranial part of the kidney. The cranial ends of both kidneys are straight with rounded edges, but the caudal end of the right kidney is more rounded, and the left end has a square shape. It should be noted that the cranial and caudal parts of the kidneys are more convex than the middle one.

In hen, the cranial margin of the right kidney lays on the last (seventh) rib, forming a rib on the ventral surface of the kidney, but the cranial edge of the left kidney does not reach the last rib and touches the caudal end of the left lung.

The external iliac and sciatic artery and vein pass through the ventral surface of each kidney, which extends at an angle of 74^0 from the descending aorta, forming deep vascular depressions, conditionally creating the separation of long kidneys into parts. These depressions are parallel to each other at a distance of 22.4 mm from each other.

Each kidney border has caudomedially border with the common iliac vein and craniomedially with adrenal glands. From the cranioventral surface, the cranial parts touch two adrenal glands, of small rounded shape and testes in males. In females, the right kidney touches well-developed left ovary.

From the medial surface, both kidneys have an uneven surface, their dorsomedial margin is blunt and more developed in the middle and caudal parts of the kidneys. Dorsolateral edge of the kidneys is acute. From the ventromedial surface of each kidney, there is an irregularly shaped portion, and in the hen, on the right kidney, this lobule is pear-shaped, larger than the left one. The left lobe is of heart-shaped form. The length of the right lobe of the kidney in the hens (male) is 13.3±0.03 mm, width – 9.91±0.04 mm, and weight – 400±0.02 g. The left part of the kidney has the length of 11.4±0.03 mm, width of 10.8±0.03 mm, and mass of 370±0.02 g. While in the hens (female) the length of the right part of the kidney is 12.3±0.03 mm, width – 9.01±0.04 mm, and weight – 350±0.02 g. The length of the left part of the kidney is 10.4±0.03 mm, width is 10.0±0.03 mm, and fraction of the right kidney, the authors note that in the hens (male) it occupies 9.30%, and in the hens (female) – 8.30% of the total mass of the right kidney, while the proportion of the left kidney has indicators the hens (male) 8.30%, and in the hens (female) – 7.50% of weight of the entire left kidney (Table 1, 2).

When carrying out morphometric studies, the authors noted that the length of the right cranial part of the kidney in the hens (male) is 21.7±0.02 mm, medium – 21.0±0.03 mm, and caudal – 22.0±0.01 mm. In the hens (female), these indices are 21.1±0.03 mm, 20.6±0.01 mm and 21.4±0.02 mm, respectively.

The length of the left cranial part of the kidney in the hens (male) is 21.2±0.02 mm, the average – 20.5±0.04 mm, and the caudal – 19.5±0.01 mm. In the hens (female), the length of the cranial part of the kidney is 20.6±0.02 mm, the mean – 20.1±0.03 mm, and the caudal length – 19.3±0.04 mm. It is clearly seen that the right kidney is longer than the left one by 2.8 mm, which can be related to the contact of the left kidney with well-developed muscular stomach (Table 3).

The noted that each part of the kidneys has different indicators. Thus, the right cranial part of the kidney of the hens (male) occupies 33.5%, the average – 32.4%, and the caudal part – 34.1%. In the hens (female), the cranial part of the kidney is 33.4%, the middle – 33.5% and the caudal – 33.1% of the entire length of the right kidney.

Table 1. Measures of an additional portion of the kidney in Haysex white hens

Indicators* __M± Δm____ Lim min - max		Length of kidney lobe (mm)		Width of kidney lobe (mm)		Lobe weight (mg)	
Type of fowl	sex	right	left	right	left	right	left
Haysex white hen	male	13.3±0.03 12.5–14.0	11.4±0.03 10.3–12.1	9.91±0.04 11.7–13.0	10.8±0.03 9.76–11.7	400±0.02 380–420	370±0.02 366–385
	female	12.3±0.03 11.4–13.0	10.4±0.03 9.90–11.0	9.01±0.04 8.66–10.2	10.0±0.03 9.00–11.0	350±0.02 340–379	300±0.02 290–330

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

Table 2. Indicators of measurement of kidney weight in Haysex white hens

Indicators* __M±Δm___ Lim min max		Total weight of kidney (mg)		Weight of parts (mg)					
Type of fowl	sex	right	left	right			left		
				cranial	middle	caudal	cranial	middle	caudal
Haysex white hen	male	4,300±0.03 4,250–4,400	4,200±0.02 4,150–4,300	1,250±0.03 1,150–1,300	950±0.03 900–1,000	1,700±0.03 1,650–1,850	1,250±0.03 1,250–1,300	950±0.03 900–1,000	1,680±0.03 4,00–5,00
	female	4,100±0.02 3,900–4,150	4,000±0.02 3,900–4,050	1,200±0.03 1,150–1,250	900±0.03 850–950	1,650±0.03 1,600–1,700	1,200±0.03 1,150–1,250	900±0.03 850–950	1,600±0.03 1,560–1,660

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

Table 3. Indicators of kidney length measurement in Haysex white hens

Indicators* __M±Δm___ Lim min max	sex	Length (mm)		Length of kidney parts (mm)					
		right	left	right			left		
Type of fowl				cranial	middle	caudal	cranial	middle	caudal
Haysex white hen	male	64.7±0.01 63.9–64.9	61.2±0.04 60.3–61.8	21.7±0.02 20.8–22.3	21.0±0.03 20.0–21.9	22.0±0.01 21.0–22.7	21.2±0.02 20.3–22.1	20.5±0.04 20.0–22.0	19.5±0.01 20.0–21.9
	female	63.1±0.02 62.6–63.5	60.0±0.04 59.3–61.2	21.1±0.03 20.5–22.0	20.6±0.01 19.6–21.8	21.4±0.02 20.4–22.0	20.6±0.02 19.2–21.9	20.1±0.03 19.5–21.0	19.3±0.04 18.6–20.2

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

Table 4. Indicators of kidney width measurement in Haysex white hens

Indicators* __M±Δm___ Lim min max	sex	Width of kidney parts (mm)					
Type of fowl		right			left		
		cranial	middle	caudal	cranial	middle	caudal
Haysex white hen	male	13.2±0.01 12.5–14.0	11.1±0.02 10.3–12.1	16.5±0.04 16.0–17.1	12.3±0.03 11.7–13.0	10.2±0.03 9.76–11.7	15.5±0.02 15.0–16.1
	female	12.2±0.01 11.4–13.0	10.1±0.05 9.90–11.0	15.4±0.03 15.0–16.0	12.0±0.03 11.6–13.2	9.06±0.02 9.00–10.0	14.5±0.04 13.8–15.1

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

Table 5. Indicators of kidney height measurement in Haysex white hens

Indicators* __M±Δm___ Lim min max	sex	Height of kidney parts (mm)					
		right			left		
Type of fowl		cranial	middle	caudal	cranial	middle	caudal
Haysex white hen	male	11.3±0.02 20.8–22.3	10.2±0.04 20.0–21.9	14.3±0.02 21.0–22.7	10.2±0.03 9.93–11.1	9.89±0.01 20.0–22.0	13.0±0.02 20.0–21.9
	female	10.1±0.03 9.95–10.9	9.97±0.03 9.06–11.1	12.5±0.03 12.0–13.1	9.96±0.01 9.02–10.9	8.94±0.02 8.05–9.97	11.2±0.03 10.6–12.2

The left cranial part of the kidney in the hens (male) is 34.6%, the middle one – 33.5% and the caudal – 31.9%. In the hens (female) the cranial part of the kidney has indicators – 34.3%, average – 33.5% and caudal – 32.2% of the entire length of the left kidney.

The width of the right cranial part of the kidney in the chicken (male) is 13.2±0.01 mm, the average is 11.1±0.02 mm, and the caudal width is 16.5±0.04 mm. In chicken (female), the width of the right cranial part is 12.2±0.01 mm, the average occupies 10.1±0.05 mm, and the caudal width is 15.4±0.03 mm.

The width of the left cranial part of the kidney in the hens (male) is 12.3±0.03 mm, the average – 10.2±0.03 mm, caudal – 15.5±0.02 mm, in the hens (female) 12.0±0.03 mm, 9.06±0.02 mm and 14.5±0.04 mm, respectively (Table 4).

The height of the cranial part of the right kidney in the hens (male) is 11.3±0.02 mm, the average – 10.2±0.04 mm, and the caudal height – 14.3±0.02 mm. In the hens (female), these data are 10.1±0.03 mm, 9.97±0.03 mm, 12.5±0.01 mm, respectively.

The height of the cranial part of the left kidney in the hens (male) reaches 10.2±0.03 mm, the mean – 9.89±0.03 mm, and the caudal height – 13.0±0.02 mm. In the hens (female), these indicators represent 9.96±0.01 mm, 8.94±0.02 mm, 11.2±0.03 mm, respectively (Table 5).

The total weight of both kidneys in the hens (male) is 8500 mg and in the hens (female) 8100 mg. Of these, the weight of the right kidney in the hens (male) is 4300±0.03 mg, the left – 4200±0.02 mg, while the weight of the right kidney in the hens (female) is 4100±0.02 mg, and the left – 4000±0.02 mg.

The cranial part of the right kidney in the hens (male) reaches 1250 mg, the average – 950 mg, and the caudal – 1700 mg. The cranial part of the left kidney occupies 1250 mg, the average – 950 mg, the caudal – 1680 mg. The cranial part of the right kidney in the hens (female) is 1200 mg, the average – 900 mg, the caudal – 1650 mg. The cranial part of the left kidney has 1200 mg, the average –- 900 mg, caudal – 1600 mg.

Analyzing the morphometric data of the cranial weight of both kidneys, the authors note that the cranial part of the right kidney in the hens (male) is 29.0%, the average of 22.0%, the caudal 39.7%, while the hens (female) on the cranial part of the right kidney accounted for 29.5%, for the middle part - 21.9%, for the caudal – 40.4% of the total weight of the right kidney.

The cranial part of the left kidney in the hens (male) is 29.4%, the average – 22.3%, and caudal – 40.0%. On the cranial part of the left kidney, the hens (female) accounts for 30.0%, for the middle part – 22.5%, for the caudal part – 40.0% of the total mass of the left kidney.

In this case, the relative mass of both kidneys in relation to the body weight of the hens (male) is 0.58%, and in the hens (female) 0.69% (Table 2).

From each kidney, oleaginous urine flows along two long ureters, which are divided into the renal and pelvic parts.

The renal part of each ureter passes inside the parenchyma of the kidney, into it from the side of the cortical zone, the secondary and primary ureters flow in as separate segments. The length of the right ureter reaches 63.0 mm, and the left ureter reaches 60.2 mm, which is associated with different lengths of the kidneys. Pelvic part of the ureter is located outside the kidney from its caudal margin to the entrance to the cloaca. The authors note that the length of the pelvic part of the right ureter is 72.2 mm, and the left 75.7 mm. The ureters flow from the ventral surface of the cloaca at a distance of 14.3 mm from each other in the form of two urodeum holes (the middle part of the cloaca), not reaching 5.8 mm to its end. Near each orifice of the ureter, there are holes of vas deferens (in males) at a distance of 2.4 mm from each other.

CONCLUSIONS

As a result of the study, the authors found that the hens have paired, whole kidneys of irregular, elongated shape that divide without visible boundaries into the cranial, middle and caudal parts, separated from each other by connective tissue.

In the hens (male), the right kidney is longer than the left kidney by 3.5 mm, and in the hens (female) by 3.1 mm, which is possibly due to the touch of the left kidney of the well-developed muscular stomach.

The ureters are divided into the renal and pelvic parts. The renal part passes inside the parenchyma of the kidney, into it from the side of the cortical zone. The pelvic part of the ureter is located outside the kidney from its caudal margin to the entrance to the cloaca. In the hens (male), next to each hole of the ureter, there are holes of vas deferens.

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