

Features of Arterial Blood Supply to the Kidneys and the Oviductal Magnum in Peking Duck

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Abstract— The sources of vascularization of the kidneys and oviducts of 5 carcasses of Peking duck were studied by pouring vessels through the femoral artery with SKS-65 latex and fixation in 4% aqueous formaldehyde solution and further preparation. As a result of the studies, it was found that within the parenchyma of each renal lobe, the intra-organ arteries branch in the main caudomedial, dorsomedial and lateromedial directions and are divided into segmental and interlobular arteries, and peritubular capillaries. Arteries of the oviductal magnum enter it at an acute angle from the side of attachment of the mesogastrium, participating in the formation of the dorsal ovarian artery, from which the arteries extending in the transverse direction are separated, covering the magnum in the form of rings and form the ventral ovarian artery. Both arteries lie on the dorsal and ventral surfaces of the oviduct, forming well-developed collaterals. All arteries form a plurality of arcuate anastomoses, but in the caudal part, the arteries are long, run parallel to each other along the longitudinal bundles of muscle fibers, forming long longitudinal anastomoses between them. Intra-organ arteries include arteries that extend perpendicularly from the dorsal and ventral ovarian arteries, forming 2-5-order capillaries on the lateral surface of the oviductal magnum parallel to the bundles of muscle fibers on the lateral surface of the magnum, while forming a fine network of numerous and well-developed anastomoses that form the surface and deep layers. Intra-organ arteries pass first under the serous membrane of the oviduct, then penetrate the muscle and mucous membranes, branch into them, forming the subserous, intermuscular and mucous plexuses. All arterial vessels of the oviductal magnum have a strongly convoluted course, and also form numerous anastomoses between themselves, forming a three-dimensional microvascular network.

Keywords—birds, arteries, kidneys, oviduct, magnum.

I. INTRODUCTION

In birds, due to high metabolism and a significant functional load on the urinary system, a large amount of arterial blood flows through the kidneys, with the help of which the main physiological function is performed to filter and excrete substances unnecessary for the body and the formation of urine crystals [1,2].

The arterial system, taking part in the vascularization of the reproductive organs of birds, provides metabolic processes, contributing, with its significant dynamic function, the production of ovalbumin.

The basis of vascularization of the oviductal magnum in birds trophic and secretory functions are of great importance, affecting the active functioning of the glands in this section to ensure timely synthesis of albumin, which is a nutrient of the embryo [3,4]. In addition, one of the main functions of the blood flow is to supply all tissues of the oviductal magnum with nutrients that influence egg formation, the excreting products of metabolism, the transfer of hormones, and regulation of the constancy of the composition of interstitial fluid, which is essential for the optimal functioning of the reproductive organs [2,5].

II. LITERATURE REVIEW

Special domestic and foreign literature describes only the main arterial vessels of the kidneys [6,7] and the oviduct of birds [2,3], but there are only few studies on vascularization of these systems in poultry. Studied the growth and development of blood vessels in chicken embryos [3,4], and paid great attention to the uterine vessels in ducks and geese in studies on the description of blood supply to the oviduct [5]. Separate studies of common sources of arterial blood supply to the oviduct in chicken have been performed [8]. At the same time, information about the spatial organization and branching features of intra-organ arteries and their hemomicrocirculation in the kidney and oviductal magnum are practically absent.

III. METHODOLOGY AND RESEARCH METHODS

The main methodological principle for obtaining scientific information was a comprehensive study of the sources of vascularization of kidneys and oviducts in Peking duck. The objects of the study were 5 carcasses aged 160–180 days. To accomplish this task, we used a complex of morphological studies of arteries that are involved in vascularization of the kidneys and oviduct using vascular filling through the femoral artery with SCS-65 latex, followed by their fixation in a 4% aqueous formaldehyde solution and preparation using an MBS-2 binocular microscope.

IV. RESEARCH RESULTS

As a result of our studies, we noted that the descending aorta serves as the great vessel in the lumbar region, from which the external iliac, paired cranial renal arteries depart at the level of the last thoracic vertebra of Peking duck and the sciatic arteries at the level of the fifth lumbar vertebra, from which the middle and caudal renal arteries branch off (Fig.1).

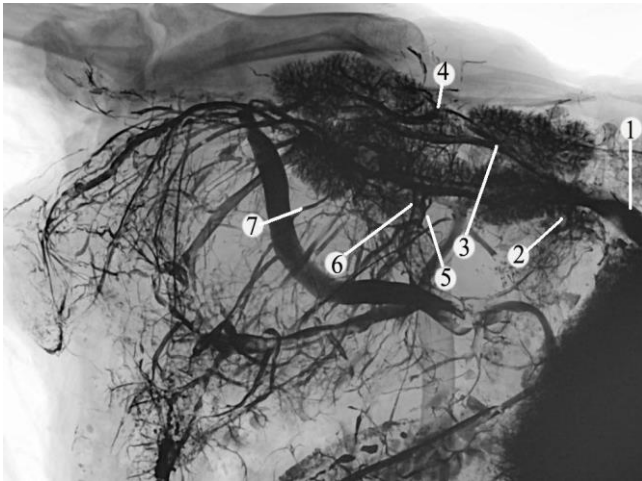


Fig. 1. Arteries of kidneys and oviductal magnum in Peking duck (x-ray). 1-descending aorta; 2-cranial renal a.; 3-middle renal a.; 4-caudal renal a.; 5-cranial magnum a.; 6-middle magnum a.; 7-caudal magnum a.

Within the parenchyma of each lobe, they disintegrate according to the main type in three directions: caudomedial, dorsomedial and lateromedial into four to five segmental arteries, which are divided into inter-lobular arteries, passing inside the interlobular connective tissue, and peritubular capillaries.

The oviductal magnum is the longest, quite mobile, along which, due to the reduction of circular muscle fibers, the yolk with its membranes is actively promoted, therefore, as a result of pressure on the arterial branches, arteries are clamped in particular areas. In the case of compression of the arteries, equal redistribution of blood is carried out, which supports the optimal vascularization of each section of the magnum. In connection with the morphofunctional feature of this section, a compensatory mechanism of collateral arterial blood circulation is developed, formed by the dorsal and ventral oviduct arteries lying on the dorsal and ventral edges of the oviduct.

The arteries of the magnum are divided into extra-organ (cranial, middle and caudal magnum arteries) and intra-organ arteries.

Arteries pass at an acute angle to the oviductal magnum from the side of the attachment of the mesogastrium, participating in the formation of the dorsal ovarian artery, from which the arteries extending in the transverse direction are separated, covering the oviductal magnum in the form of rings and form the ventral ovarian artery. Both arteries lie on the dorsal and ventral surfaces of the oviduct, forming well-developed collaterals (Fig.2).

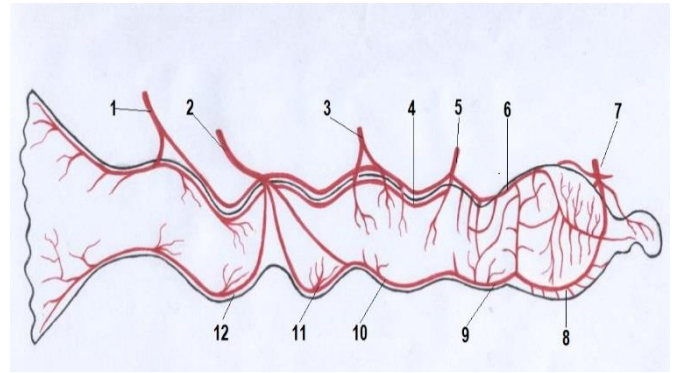


Fig. 2. Arterial blood supply to the oviductal magnum in Peking duck: 1 - cranial renal a., 2 - cranial magnum a., 3 - middle magnum a., 4 - dorsal oviductal a., 5 - caudal magnum a., 6 - cranial uterine a., 7 - internal iliac a., 8 - a caudoventral uterine a., 9 - a cranioventral uterine a., 10 - a ventral oviductal a., 11 - a caudoventral magnum a., 12 - a cranioventral oviductal a.

The cranial magnum artery departs from the left renal artery, branches off from the dorsal ovarian artery, and divides into the cranioventral, caudoventral and caudolateral arteries.

The cranioventral magnum artery is directed along the lateral surface of the oviductal magnum, bending in an arc, passes cranioventrally, reaching its ventral surface and participating in vascularization of the anterior third of the oviductal magnum and the oviduct funnel.

The caudoventral artery is directed to the ventral edge of the oviductal magnum, bending in an arc, passes caudally to the ventral surface of the oviduct, participating in the formation of the ventral oviduct artery.

The caudolateral artery of the oviductal magnum is divided into two branches. One of them passes along its dorsal surface, and the other is directed ventrally, participating in the formation of the ventral oviductal artery, into which the cranioventral uterine artery flows.

The middle magnum artery of the oviduct departs more often with the common trunk along with the caudal and middle renal arteries, or less often independently, branching from the left external iliac artery. Then it approaches the dorsal mesentery of the oviduct and, before entering the dorsal ovarian artery, is divided into the cranial and caudal branches. Three arteries extend from the dorsal ovarian artery into the middle part of the oviductal magnum, which are directed perpendicular to the axis of the organ along its lateral surface, branching on the dorsal and lateral surfaces of both sides of the middle part of the magnum.

The caudal magnum artery is separated from the sacral artery, which then departs from the internal iliac artery. It enters the dorsal magnum artery of the oviduct and after that gives off five arteries. One of them is directed cranioventrally into the middle of the oviductal magnum, and the rest participate in vascularization of its posterior third. These arteries pass along the lateral surface of the posterior part of the oviduct, form anastomoses between themselves and flow into the cranioventral uterine artery, which is also involved in the formation of the ventral ovarian artery. A thin branch is separated from the caudal magnum artery, which passes along the ventral surface of the ureter and, giving three short and one long descending branches to its wall, participating in its vascularization.

All arteries pass along the lateral surface of the posterior part of the oviduct, form anastomoses between themselves and flow into the cranioventral uterine artery, which is also involved in the formation of the ventral ovarian artery.

In the cranial third of the oviduct, the arteries enter the oviductal magnum at acute angles, and on average, they form many arched anastomoses between themselves, but in the caudal section, the arteries are long, run parallel to each other along the longitudinal bundles of muscle fibers, forming long longitudinal anastomoses between themselves.

Taking into account the peculiar branching of arterial vessels in the cranial, middle and caudal parts of the oviductal magnum, we can assume their unequal functional significance in the formation of different layers of egg albumin in it. It should be also noted that the passing time of the ovicell is slow when moving along the longest section of the oviduct and takes approximately 20 hours.

Intra-organ arteries include arteries that extend perpendicular from the dorsal and ventral ovarian arteries, forming 3-5 order capillaries on the lateral surface of the oviductal magnum, located parallel to the bundles of muscle fibers, while forming a fine network of numerous and well-developed anastomoses that form the surface and deep layers. Intra-organ arteries pass first under the serous membrane, and then penetrate into the muscle and mucous membranes, branching into them.

In the surface layer, the capillary network of the serous membrane is represented by large polygonal cells with a strongly tortuous course of arteries in all parts of the oviductal magnum, forming a subserous plexus.

In the serous membrane of the anterior part of the oviduct, strongly convoluted intra-organ arteries are observed that have the main branching type, and when the branches are distributed in the thickness of the muscle membrane, they correspond to the arrangement of bundles of muscle fibers, forming microscopically visible branching arteries up to branches of 4-5 order. At the same time, there is a large number of strongly convoluted intramuscular deep layer anastomoses, located especially between closely spaced fibers, which may indicate a single intramuscular arteriovenous bed. The latter circumstance is important in relation to the vascularization of the structures of the oviductal magnum and indicates the richness of arterial blood supply, which is very important in the functional significance of this part.

In the mucous membrane, the most powerful are the arterial submucosal plexuses, which are finely pleated and are formed by 3-4 order branches involved in the vascularization of the glands that secrete egg-white protein, as well as many non-expanding folds of the mucous membrane of the oviductal magnum.

Straight and recurrent arteries and arterioles depart from the arterial plexus into the own mucous layer and into the muscle membrane. Veins and venules flow into the venous submucosal plexus. We noted that a three-dimensional microvascular network with a large number of straight and convoluted arterio-venular anastomoses is formed inside the membranes of the oviductal magnum.

As a result of our studies, we determined some patterns of the course and branching of intra-organ arterial vessels in various parts of the oviduct. Thus, the anterior part of the

oviduct is characterized by the main type of branching of the vessels and, occasionally, their dichotomous division.

In the middle part, in addition to the trunk type, there is also a loose branching type having rami laterales, which are interconnected by intersystem anastomoses on the lateral surface of the oviduct, departing from the dorsal and ventral oviduct arteries and forming annular anastomoses between them.

In the main vessels, there is rapid blood flow and intense metabolism in the tissues, and a large area of interaction with the tissues is covered in the vessels of the loose type.

In the caudal part of the magnum, to a greater extent, a parallel arrangement of strongly convoluted arteries with numerous short anastomoses between themselves is noted.

V. PRACTICAL SIGNIFICANCE

The obtained results allow us to establish the features of arterial vascularization of the intra-organ vessels of the kidneys and the oviductal magnum in the Peking duck, which is important for the morphological and functional assessment connected with the features of the functional value of these organs.

The obtained factual material can be used in the educational process to study the anatomy of the kidneys and oviduct of birds in ultrasound investigation with further diagnosis. In addition, the results can be useful for writing the corresponding sections of educational guidance and reference manuals for specialists in the field of the poultry industry.

VI. DISCUSSION

The high intensity of metabolic processes causes many kidney functions with a fairly easy transition of substances from arterial blood to parenchyma cells and in the opposite direction, which is achieved by a large contact area in the vascular glomeruli of arterial blood with venous blood [9]. The absorption processes are accompanied by the reabsorption of large amounts of water, salts, that coincides with the opinion [10,11].

Arched arteriovenous anastomoses are formed in the redistribution of one section of the oviduct. It is possible that this type of branching is one of the ways of duplication of arterial vessels in the general circular system of the oviduct, thereby increasing its reliability, which is consistent with the data [5]. The presence of arcuate anastomoses is functionally adaptive and is important in the uniform redistribution of blood in the oviductal magnum during the formation of egg albumin.

The dorsal and ventral ovarian arteries throughout their length are represented by strongly convoluted arched vessels located at the level of the dorsal and ventral edges, forming intrasystem anastomoses of the entire oviduct. Between them, a dense network of anastomoses with narrow, strongly convoluted capillaries along the bundles of muscle fibers is formed on the sidewall of the magnum. This circumstance emphasizes the interdependence of the form and function and the relationship between the nature of the arterial bed of muscles and the morphofunctional adaptation of the muscles, taking into account the different structural organization of the oviductal magnum. Inside the oviductal magnum, there is a significant number of anastomoses between 1-5 order branches extending from the main sources of nutrition. The

presence of abundant anastomoses gives an indication of the unity of the arterial bed inside the serous, muscle and mucous membranes, despite the food sources multiplicity.

VII. CONCLUSION

Our research found that the sources of renal vascularization are the cranial, middle and caudal renal arteries, which break up into segmental and interlobular arteries, and peritubular capillaries within the parenchyma of each lobe.

All arterial vessels of the oviductal magnum have a strongly tortuous course and also these vessels form numerous anastomoses between themselves, forming a three-dimensional microvascular network, forming the subserous, intermuscular and mucous plexuses in the magnum.

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