MORPHOLOGY OF THE AORTIC VALVE
OF GALLUS GALLUS F. DOMESTICA

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Abstract

The aim of the research was to determine the morphological types of the aortic valve of domestic fowl. One hundred and six birds were used in the study (52 males and 54 females). Sections at various levels were made as well as corrosion preparations. Morphologically, two types of valves were distinguished: a tricuspid valve and a quadricuspid valve. The quadricuspid structure of the aortic valve is very rare in the animal world, whereas in the humans, it is most frequently connected with existing inborn defects of great vessels.

Key words: chickens, aortic valve, morphology.

Linnaeus in “Systema Naturae” (1758) listed 564 species of known birds (23), whereas contemporary sources claim the number reaches more than 9800 (9, 28). Among individuals belonging to Aves group there is a great diversity in the structure of particular systems, which is the result of their adaptability to various living environments. Special attention should be paid to the circulatory system and heart of birds (11-13, 20), which show a considerable morphological variability depending on lifestyle of a given species (4, 6, 7). There is not much literature referring to the anatomical structure of the heart of birds (10, 11). However, there are some studies in which authors link morphology to the adaptability of individuals of a given group to various models of life (9). One of the most important works connected with the subject is the publication by Drabka (11). He was the first to collect and publish data concerning the structure of the heart of species of the Emperor Penguin (Aptenodytes forsteri), Chinstrap Penguin (Pygoscelis antarctica), and Adelie Penguin (Pygoscelis adeliae). The research explained the differences between the anatomy of the heart of penguins diving in shallow waters and the heart of those penguins diving deep (12, 13).

Most of the publications concern the changeability of the valve system and location of the coronary arteries and aortic valve of mammals, especially laboratory animals (8, 16). There is very little research of this valve types as far as birds are concerned (1, 30). In clinical research, there is an ever growing need to determine some standards to methods of pictorial diagnostics (5, 26). Such research is conducted in rare and valuable bird species as well as domestic birds, mainly on chicken embryos (3, 21, 22).

Morphological examination of the heart of rare and valuable birds are difficult to do; therefore, the authors of the presented research decided to study the heart of a chicken first, as it is the most common livestock species. The research of the valve type will allow indicating the chicken breed, which will be free of developmental defects within the heart, especially of the coronary vessels. It will minimalise the death of the animals due to circulatory insufficiency, among other things caused by fast growth of muscle mass.

Material and Methods

The research was conducted on 106 hearts of dead adult chickens (52 males and 54 females). The animals were taken from private chicken breeders from districts of Lubuskie, Mazowieckie, Lubelskie, and Podlaskie voivodships from 2005 to 2007.

After evisceration, the hearts were washed in NaCl solution heated to 42°C and supplemented with surface active agents and ethanol. Then, their outer and inner sides were dried with filter paper and an aspirator of our own construction.

The material was divided into the following groups and treated as follows:
- hearts of 25 males and 25 females were fixed in 10% formaldehyde for 6 weeks. Twelve hearts of each sex were injected with technical gelatine with some ink added and kept at -18°C for 60 min. The frozen material was cut with an electric saw “Alaska FS 2000” into two-millimetre sections perpendicularly to the surface;
- hearts of 27 males and 29 females were injected with “Wiedent” material, a substance with hardening properties. In order to achieve corrosion preparation of the aortic valve, the material was subjected to bioenzymatic maceration for three weeks. On such a prepared material, openings of the coronary arteries were defined and morphological description of the valves was made with the use of light (OPM1) and stereoscopic (MST-130) microscopes. The photographic documentation was taken with the use of a video camera (MikroOkular 3.0MP) and a camera (Nikon CoolPix 5700).

Results

The conducted observations of the aortic valve did not show any significant differences in macroscopic structure between males and females connected with the sexual dimorphism. The situation makes it possible to treat the results cumulatively.

The examinations also showed that there were two types of chicken aortic valves: type A, which consisted of three cusps, i.e. left semilunar cusp, right ventral semilunar cusp, and right dorsal semilunar cusp, and type B, which consisted of four cusps, i.e. left semilunar cusp, left semilunar accessory cusp, right ventral semilunar cusp, and right dorsal semilunar cusp (Figs. 1 and 2).

Three basic locations of the openings of the coronary arteries were recognised: I – at the level of the free border of the cusp, II – below the free border of the cusp within the aortic sinus, and III – above the free border of the cusp (Fig. 3). During the analysis of the location of the coronary artery openings, single openings of the coronary arteries of type II were found in 18 individuals in the aortic valves within the right dorsal aortic sinus. The authors suggest that it should be called median coronary artery - *arteria coronaria mediana* (Fig. 4). The vessel runs in the interatrial groove and goes up, directing branches to the front wall of the right atrium and front wall of the left atrium (Fig. 5).

**Fig. 1.** The aortic valve (corrosion cast). Type A: 1a) view from below; 1b) front view; a – the left semilunar cusp; b – the right semilunar ventral cusp; c – the right semilunar dorsal cusp.

**Fig. 2.** The aortic valves (corrosion preparation). Type B: 2a) view from below; 2b) front view; d – the left semilunar accessory cusp (other denotations see Fig. 1).
Fig. 3. Types of location of the openings of the coronary arteries (the aortic valve cut and gaped); 1 – the opening of the left coronary artery; 2 – the opening of the right coronary artery; the level of the free border of the cusp marked with a dashed line.

Fig. 4. 4a - the aortic valve, 4b – cut and gaped; 3 – the opening of the median coronary artery (other denotations see Fig. 3).

Fig. 5. The aortic valve – view from above, 1 – injected with technical gelatine with some ink added, c – the median coronary artery.

Table 1

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Discussion

Available publications describe the coronary arteries in particular species of mammals, e.g. deer (17), dog (24), Syrian hamster (14), donkey (27), seal (29), and even human (19) in a detailed way. On the basis of the conducted observations, the authors recognise the left coronary artery and the right coronary artery, which are present in mammals and birds.

The research conducted on avian heart showed the presence of an accessory opening of the coronary artery from the dorsal aortic sinus. The presented results are a part of a broader research on various representatives of Aves group, especially galliformes order.

In world literature, there are not many publications concerning the structure of the aortic valve of birds. The research conducted on the population of pigeons, starlings, and thrushes showed that the valve of the aortic bulb consists of three cusps. As far as pigeons and thrushes were concerned, there were three cusps recognised: the left front cusp, the right front cusp, and the back one, whereas starlings’ heart has one front cusp and two back cusps (the right and left ones) (18). The presented results confirm a tricuspid structure of the aortic valve of Aves group.

Out of 106 studied hearts of chickens, only four had the quadricuspid aortic valve (Fig. 2). The available literature does not provide studies concerning the accessory cusp of the aortic valve; therefore, the authors suggest the following terminology: the left semilunar cusp, the left semilunar accessory cusp, the right semilunar ventral cusp, and the right semilunar dorsal cusp. The difference in heart structure observed only in four individuals does not allow for claiming that birds can develop four-cusp valves. A quadricuspid structure of the aortic valve classified as type B is only a stimulus to further research, which will allow explaining whether the structure is regular or appears sporadically. As far as humans and other species of mammals are concerned, the difference in the number of cusps of the aortic valve is considered a pathological change. Due to differences in the terminology, we suggest that the following terms should be used to describe the structure of the valve system for particular individuals (Table 1).

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**References**


