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The Morphological Aspects of Bone Marrow of Guinea Fowl of the Volga White Breed in Postembryonic Ontogenesis.

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ABSTRACT

The paper presents materials on age-related morphology of the bone marrow of Guinea fowl of the Volga white breed. The bone marrow is placed in the cancellous cells, and in the postembryonic period its absolute mass increases, and the relative weight, on the contrary, decreases. The highest content of the bone marrow in the skeleton of a Guinea fowl is observed in the period from the 1-st till the 60-th days of life. The volume of the bone marrow in the male Guinea fowl is higher than in the female Guinea fowl on 1,7+0,15%. The main mass of the bone marrow in a newborn Guinea fowl is placed in the peripheral skeleton, and more than 45% in the humeral, femoral and tibial bones. As for the axial skeleton, most of it is concentrated in the iliac bone and the lower jaw. Further the number of a bone marrow sharply increases and reaches a maximum to the 60-th day of life, consisting of 37.10+of 1.51% from the total content of the skeleton of a Guinea fowl. Then this figure stabilizes and to the 90-th day of life it consists of 34,90+1,89%. From the 180-th day of life the amount of a bone marrow in the skeleton begins to decrease and to the 365-th day it consists of only 23,10+of 1.11%. Microscopy of smears of a bone marrow finds an individual fat cells in it from the 60-th day of life. By the time of a puberty is observed a gradual replacement of a red marrow to the yellow and to 180-th day it is only 15,75+1,28%. By the 365-th of life a bone marrow is mostly yellow with a single foci of hematopoiesis in its structure, up to 8,31+1,56%.

Keywords: bone marrow, skeleton, Guinea fowl, ontogenesis

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INTRODUCTION

The development of the poultry industry in the Russian Federation without any doubt is not only associated with the breeding of chickens, ducks and geese, but also with the development of the alternative directions in the poultry industry. One of those is the breeding and rearing of Guinea fowl [1].

There are an extensive materials on the selection, breeding and raising of Guinea fowl, the enough material is accumulated for their feeding and incubation. However, unfortunately, there`s a very few materials that relate to the morphological aspects of the body structure of Guinea fowl and organs of hematocytopoiesis in particular.

An integral function of bone as the organ is the hematopoiesis, performed by its structural part – marrow. It should be noted that a bone marrow is not only provides hematopoiesis, but also participates in the metabolic processes of the body, ensuring a higher strength of bone, hardness - a resistance to the biochemical effects of the load at different degrees of locomotion, as well as the lightness and elasticity. The high biological value lies in the fact that the bone marrow is localized in the deepest depths of the bones, filling all the space between the bone and the trabecular beams [2, 3, 4].

In the process of phylogenesis the bone marrow appears in the skeleton only in the terrestrial animals and goes through the three stages of a development: osteoblastic, hematopoietic and the stage of involution. In the embryonic period is observed the osteoblastic stage, then due to the birth (hatching) and the extinction of hematopoietic function of the liver is observed a hematopoietic stage, which moves into a phase of a yellow bone marrow by the time of a puberty.

Bone marrow in the evolution of vertebrates gradually increases in a volume and in a relative mass along with the increasing of the relative mass of blood and a supplement of the body with hemoglobin [5]. The bone marrow most of all could satisfy the rising demands of terrestrial vertebrate in the oxygen, and together with the whole bone they were the first perceiving the intensity of motion in a gravitational field. Changes in the intensity of locomotion led to the increase in hematopoiesis, which is a direct proof of the great dependence of hematopoiesis from the locomotor activity of the animal.

Bone marrow among the terrestrial higher vertebrates reaches up to 6-7% of a body weight or 40-50% of the mass of the skeleton. It is proven that the more active an animal is, the more bone marrow contains in the skeleton. So, the number of a bone marrow of a reindeer reaches up to 12.8% relative to the body weight, and in rabbits is only 2%. The indicators of the quantitative ratio of the bone marrow are also interesting [2, 3]. It turned out that in mammals the localization of the bone marrow in various parts of the skeleton varies considerably. Sternum and the vertebral ends of the ribs contain up to 70 % of a weight of the bone marrow. On average, the thoracic vertebrae contain 47.5% of a bone marrow, sternum — 59,2% and ribs of 39.8% of their weight.

The accounting for the mass distribution of the bone marrow by the divisions of the skeleton shows that the main mass of it in mammals is localized in the axial skeleton (50,5%), then pelvic girdle (38,7%) and the least in the shoulder (10.8 %).

A significant feature of the distribution of a bone marrow in birds is the factor that it is localized mainly in the peripheral skeleton, whereas in the axial its quantity is very small, or is missing. Due to the lack of a bone marrow in certain age periods in the bones of the axial skeleton and the long bones of the arm and forearm, many birds have a reduced total number of a bone marrow in their body. Interestingly, that the chicks have significantly less marrow than those of mammals [4, 6].

All the above indicates that in animals and birds, leading an active lifestyle, the skeleton should have a more powerful development of a bone marrow compared to less mobile animals. The functional state of the bone marrow affects the bone. So, the bone of a young animal, containing red marrow has a significant amount of cobalt, which is absent in the bone with a yellow marrow.

Bone marrow in mammals and birds is within the cells of cancellous bone, in the system Gaversov`s channels, and also completely forms the medullary portion of the diaphysis of tubular bones [7, 8, 9].

Red bone marrow is a myeloid tissue and up to 50% of its mass is presented with the blood vessels. The bone marrow is high innervated, is rich with the interoreceptors and is a powerful reflexogenic zone. Under the microscope the myeloid tissue of a bone marrow looks like a kind of cords, splits into segments, consisting of compactly packed cells forming cylindrical clusters around the arterioles.

Each of these segments is separated by the draining sinusoids. The reticular fibers and cells make up the skeleton of medullary cords; being in a contact with each other with a thin branching spikes, they form a spongy stroma, with a hematopoietic cells in its loops. In addition to reticular cells, fibroblasts and hematopoietic cells - the labricits (fat cells) and macrophages can be found in the cords, lying near the venous sinuses. Macrophages phagocytose cellular detritus, core and up to 2% of the whole cells of erythroid series. The defective hematopoietic elements are mainly exposed to phagocytosis. Macrophages, which are the basis of the erythroblastosis islets, tightly cover with their processes the surrounding erythroid cells.

The topography of hematopoietic cells in the bone marrow is determined, on the one hand, with their location relative to the vessela and, on the other hand, relative to the surface of endosteum. The morphological studies of the bone marrow sections showed that the zone of the most active hematopoiesis is always bordered by endosteum. The early forms of cells of myeloid series are mainly observed close to the bone, while the myelocytes and granulocytes are located in the central portions of the bone marrow.

Structure and a function of a bone marrow, the changes taking place in it in a connection with the development in phylogenesis and ontogenesis in response to many external and internal factors, the regeneration of hematopoietic tissue after damage, are closely associated with the inner bone vascular system. It meets the needs of the bone marrow cells in food, oxygen and a delivery of hormones. An important structural component, which is directly involved in its main function - the supplying of a peripheral blood with the hematopoietic cells that have reached the necessary maturity, is a vascular wall of a bone marrow. Through its wall the cells emigrates into the blood. It serves as a barrier between the myeloid tissue and a blood stream, provides the conditions under which the emigration of cells from the bone marrow and a migration of progenitor cells into the bone marrow become orderly [10, 11, 12, 13].

However, in the bone marrow unlike the other organs and tissues in addition to the conventional venous capillaries there are some more special formations of a microvasculature—sinusoids. The sinusoids are extended up to 500 μm and more alveolar-like capillaries of the bone marrow, for the most part are located close to the endosteum surface of the bone, which could even be the wall of the sinusoid in this case. The distal part of sinusoids is mainly the capillaries that are coming out from the bone. According to this the bigger part of the bone marrow of a blood arriving in the sinusoids manages to contact with the bone tissue.

Knowledge of the structural organization and patterns of a development of the bone marrow is the key to understanding, disclosure and a prevention of pathology in this organ.

The goal of a research: to study the age morphology of a bone marrow of Guinea fowl of the Volga white breed at the main stages of the postembryonic ontogeny.

MATERIALS AND METHODS OF A RESEARCH

The object of the study was the newborn, 60-th day, 90-th day, 180-th day, 270-th day and 365-th day of life Guinea fowl grown in CJSC "Mariyskoye". The material for the study was the bone marrow of the axial and a peripheral skeleton. The morphological characteristic of a bone marrow was studied visually and was supplemented by the researching of the main morphometric measurements (mass, volume). Along with the preparation was studied the histological structure of a bone marrow on the smears-prints, dyed with hematoxylin-eosin. During the examining of a Guinea fowl skeleton in a whole and in the separate parts and bones we have identified the main morphological and topographic anatomical features of the bone marrow.
Some separate parts of work in terms of validation of the obtained results were reproduced on the equipment of the laboratory of clinical veterinary medicine of the agrarian faculty of RUPF, acquired in the framework of the innovative project "Education". The obtained digital data were processed by methods of variation statistics using the student's “t” test with a PC and a software package Microsoft Excel.

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Discussion and results of a research

Data on the content of a bone marrow in the body of Guinea fowl Volga white breed are presented in table 1 and the diagram 1.

Table 1: The dynamics of the relative weight of the bone marrow of Guinea fowl comparing to the live weight and the absolute mass of the skeleton

Index	Пол	Age, days					
		1	60	90	180	270	365
The percentage of the relative weight of the bone marrow to the live weight, %	♂	0,92+0,08	5,50+0,47	5,15+0,64	4,68+0,31	2,92+0,08	2,60+0,11
	♀	0,87+0,02	5,41+0,37	4,99+0,21	4,51+0,74	2,85+0,08	2,58+0,07
The percentage of the relative weight of the bone marrow to the mass of the skeleton, %	♂	6,75+0,31	37,10+1,51	34,90+1,89	30,92+1,76	27,19+1,55	23,10+1,11
	♀	6,59+0,54	36,92+1,71	34,01+1,77	30,19+2,01	26,65+1,66	22,84+1,55

From table 1 it is seen that in the period from the 1-st till the 60-th days of life was observed the highest content of a bone marrow in the skeleton of a Guinea fowl. In this period the rapid growth of all parts of the skeleton and the accelerated formation of tissues and organs throughout the body are observed. And when you consider that a bone marrow actively participates in the metabolic processes in the body, it becomes clear that such a high content of a bone marrow in the body of the Guinea fowl is a morphological requirement in this period. According to the data of table 1 the bone marrow of Guinea fowl is characterized by the sexual dimorphism, which manifests in the fact that the male Guinea fowl have the higher volume of a bone marrow comparing with the female Guinea fowl, more on 1,7+0,15%.

In the body of chicks during the first two months of their life the amount of a bone marrow increases almost in 6 times. It should be noted that this is the only sharp abrupt increase in the content of a bone marrow in the skeleton of a Guinea fowl; in the future this considerable increase in the mass of the bone marrow is not observed in any of the studied periods.

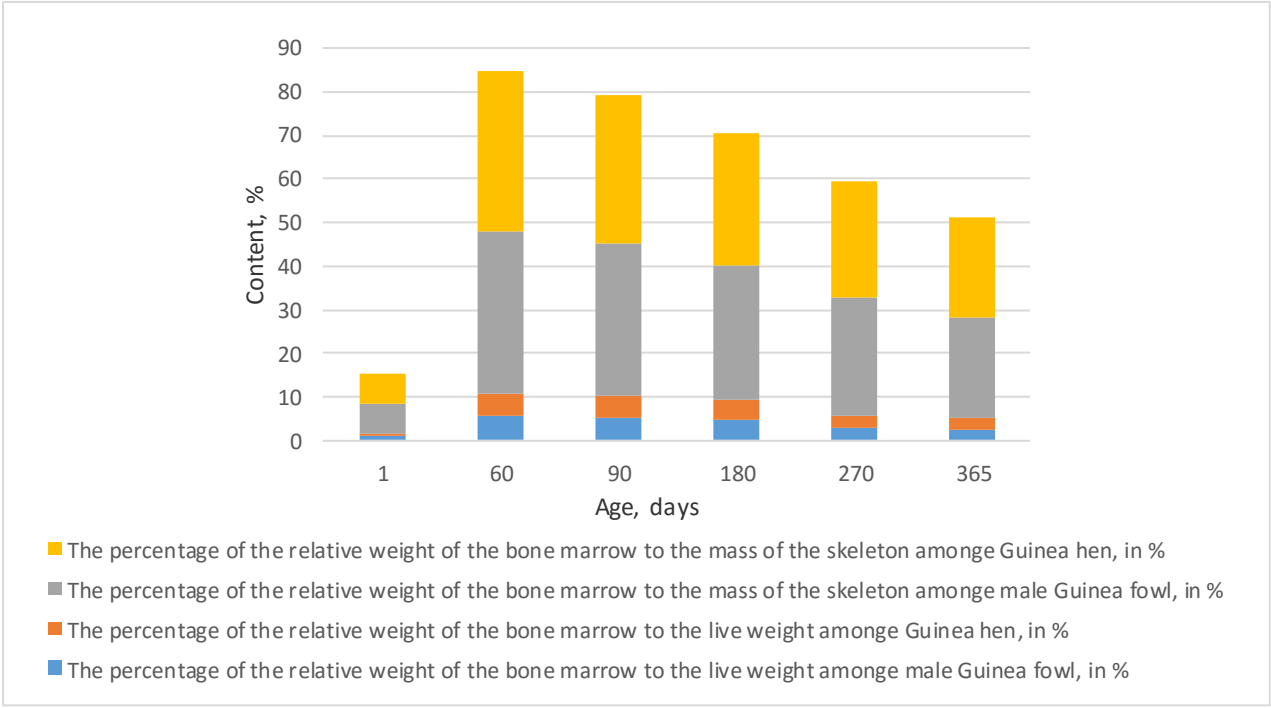
The main mass of the bone marrow of chicks is noted in the peripheral skeleton, and more than 45% in the humeral, femoral and tibial bones. According to the obtained results, the foci of hematopoiesis are also found in coracoid, clavicle, ulnar, radial, the carpal-metacarpal and tarsal-metatarsal bones. As for the axial skeleton, most of the bone marrow is concentrated in the ilium, the upper and the lower jaw. Further on, the number of a bone marrow sharply increases and reaches a maximum at 60-th day of life, consisting of 37.10+of 1.51% of the total content in the skeleton of a Guinea fowl. Further, this figure stabilizes and to the 90-th day consists of 34,90+1,89%. From the 180-th day of life begins the decrease in the amount of a bone marrow in the skeleton and to the 365-th day of life the figure is only 23,10+of 1.11%. At the age of 365 days, the bone marrow in the body of a Guinea fowl in 2.11 times lower compared to the same parameter at the age of 60 days and in 1.98 times at the age of 90 days.

Scheme 1 clearly shows that the peak of a saturation of the skeleton with the bone marrow was observed in the first two months of life of Guinea fowl. Then the indicator is stable and until the age of 90 days varies slightly. Even in the next 90 days, this indicator decreases smoothly. From the 180-th day of life begins a sharp drop in the saturation of the skeleton of a Guinea fowl with a bone marrow. At one year of age the figure is only 57,12+2.34% from the saturation of the skeletal bone marrow at the age of 90 days.

While growing up, a red marrow is replaced by a yellow bone marrow, i.e. the substitution of the myeloid tissue to fat. With a help of microscopy of smears of a bone marrow an individual fat cells could be

found in it from the 60-th day of life. By the time of a puberty there is a gradual replacement of a red marrow to a yellow and to the 180-th day of life, it is only 15,75+1,28%. At the age of 365 days a bone marrow is mostly represented in a yellow and its structure meets single foci of hematopoiesis, consisting 8,31+1,56%. Thus, according to our study, a bone marrow of the Guinea fowl is characterized with the certain morphological features, which reflect the nature of adaptation of the red bone marrow to the changing habitat conditions and are based on the general biological regularities of ontogenesis orientation.

Scheme 1. A retrospective of the relative content of a bone marrow in the body and the skeleton of a Guinea fowl of the Volga white breed



Insights

- The main mass of the bone marrow in the Guinea fowl is noted in the peripheral skeleton, and more than 45% of the humeral, femoral and tibial bones. Further on, its absolute mass increases, and the relative weight on the contrary, decreases.
- The bone marrow of Guinea fowl is characterized by the sexual dimorphism, which manifests in the fact that the male Guinea fowl have the higher volume of a bone marrow comparing with the female Guinea fowl, more on 1,7+0,15%.
- By the time of puberty there is a gradual replacement of a red marrow to a yellow and to the 180-th day of life, it is only 15,75+1,28%. At the age of 365 days a bone marrow is mostly represented in a yellow and its structure meets single foci of hematopoiesis, consisting 8,31+1,56%.

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