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Morphological Features of the Adrenal Gland of White Giant Rabbits

U. A. Rakhmonov
Independent researcher, Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnology

N. B. Dilmurodov
Professor, Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnology

ABSTRACT

This article analyzes the literature on the anatomical and histological characteristics of the adrenal glands in rabbits and presents data based on this.

KEYWORDS: Hormones, catecholamine, adrenaline, noradrenaline, mineralocorticoid, glucocorticoid, androgen, estrogen, cortisone, chromaffin kidney, adrenal gland, cortex, medulla.

Relevance of the Research Topic: The Resolution of the President of the Republic of Uzbekistan No. PQ-121 dated February 8, 2022, emphasizes the further development of livestock sectors, financial support of livestock farms, expansion of the fodder base, and the organization of livestock breeding in household farms through cooperation with large livestock enterprises and processing companies. Within the framework of this resolution, special attention is being paid to the development of promising livestock branches, including rabbit breeding.

In recent years, increasing attention has been given to rabbit farming in the Republic. Rabbit breeding plays an important role in meeting the population's demand for dietary meat, meat-and-skin products, and valuable fur. Rabbit meat is recommended as a dietary food due to its high digestibility, low fat content, and high biological value.

The scientific development of rabbit breeding, improvement of productivity, and enhancement of sector profitability require comprehensive study of physiological and morphological processes occurring in the rabbit organism. In particular, the adrenal glands play a crucial role in metabolism, stress adaptation, growth, and development processes in rabbits. The cortical and medullary layers of the adrenal glands produce essential hormones such as mineralocorticoids, glucocorticoids, androgens, estrogens, as well as adrenaline and noradrenaline, which are vital for maintaining homeostasis and normal physiological functions of the organism.

Identification of morphological changes occurring in the adrenal glands during different physiological stages of postnatal ontogenesis is of significant theoretical and scientific importance in studying the biological characteristics of rabbits. These data provide a scientific basis for the rational use of rabbits with consideration of their biological potential, prevention of metabolic disorders, and improvement of productivity.

The adrenal glands (glandulae suprarenales) are vital endocrine organs in humans and vertebrate animals. They are paired glands located above the right and left kidneys. In rabbits, the average weight of the adrenal glands ranges from 0.3 to 0.5 g. Structurally, the glands consist of an outer cortical layer and an inner medullary layer, each representing a functionally and morphologically independent endocrine unit.

Numerous studies have investigated the structure of the adrenal glands in humans and domestic animals such as cattle, pigs, dogs, and goats. However, the morphological features and postnatal development of the adrenal glands in rabbits remain insufficiently studied, particularly during different stages of postnatal development.

The adrenal cortex produces three types of steroid hormones that differ in their biological effects. These hormones are synthesized from cholesterol and ascorbic acid and are directly secreted into the bloodstream.

Considering the above, the study of postnatal morphogenesis and functional characteristics of the adrenal glands in rabbits is a relevant scientific problem, providing important theoretical and practical significance for the scientific development of rabbit breeding, enhancement of productivity, and improvement of sector efficiency.

Table 1. Hormones of the Adrenal Glands

Adrenal gland layer	Hormone	Physiological function
Adrenal cortex (Zona glomerulosa)	Mineralocorticoids (Aldosterone)	Regulation of water–electrolyte balance, sodium retention, potassium excretion, and maintenance of blood pressure
Adrenal cortex (Zona fasciculata)	Glucocorticoids (Cortisol, Corticosterone)	Regulation of carbohydrate, protein, and lipid metabolism; stress response; anti-inflammatory and immunosuppressive effects
Adrenal cortex (Zona reticularis)	Androgens (Dehydroepiandrosterone – DHEA, Androstenedione)	Development of secondary sexual characteristics; participation in growth and metabolic processes
Adrenal medulla	Adrenaline (Epinephrine)	Activation of the “fight-or-flight” response; increase in heart rate, blood pressure, and blood glucose levels
Adrenal medulla	Noradrenaline (Norepinephrine)	Regulation of vascular tone, blood pressure, and stress adaptation mechanisms

Mineralocorticoids (aldosterone, corticosterone, deoxycorticosterone) regulate mineral metabolism; among them, aldosterone is the most biologically active and plays a key role in regulating water–salt balance in the organism. Among glucocorticoids, hydrocortisone participates in protein, lipid, and carbohydrate metabolism, enhances the organism’s resistance to diseases, and promotes rapid resolution of inflammatory processes. The sex hormones of the adrenal cortex-androgens and estrogens-regulate the activity of the gonads and ensure the development of reproductive organs during early life; however, their significance decreases after sexual maturity.

The adrenal medulla produces the hormones adrenaline and noradrenaline. These hormones act on nerve endings and regulate the functioning of the cardiovascular system. Damage to the adrenal glands may lead to various diseases, such as Addison's disease ("bronze disease"). The activity of the adrenal glands is regulated by the nervous system and the cerebral cortex [6].

The normal morphological structure of the adrenal glands in animals has been studied by many researchers [13,10,2].

Among the endocrine glands, the adrenal gland is highly sensitive to stress. The cortisone hormone produced by this gland is responsible for adaptation, resistance, and tolerance of the organism to stress. Numerous scientific studies have been conducted to investigate the morphofunctional state of adrenal gland cells and tissues [11,4,12].

In mammals, the adrenal glands play a crucial role among endocrine organs in regulating vital physiological processes [5,9,8]. The adrenal cortex is an absolutely essential tissue for life; removal of this layer leads to death of the organism.

The hormone of the chromaffin system-adrenaline enhances glycogen breakdown in the liver, increases blood glucose levels, and elevates the tone of smooth muscles in many organs. Noradrenaline has a stronger and more prolonged effect compared to adrenaline. Certain paraganglia (e.g., the carotid body, *glomus caroticum*) are considered reflexogenic zones rich in sensory nerve elements.

The cortical substance of the adrenal gland and interrenal bodies develop from the mesodermal epithelium covering the coelomic cavity, which also gives rise to the genital ridges. A cluster of chromaffinocytes originating from neuroblasts of adjacent sympathetic ganglia grows into the developing cortical primordium and subsequently forms the medullary substance.

Histological structure of the adrenal gland. The surface of the gland is covered by a capsule composed of fibrous connective tissue. Radial trabeculae extend from the capsule into the organ. Reticular fibers form the main supporting framework of the gland. Based on cell shape, size, and arrangement of cellular cords, three distinct zones are differentiated within the cortex.

The reticular zone (*zona reticularis*) consists of anastomosing cords of cells resembling those of the fasciculata zone. Lipid content in these cells is lower than in the cells of the zona fasciculata.

Histochemical studies have revealed vitamin C granules in the cytoplasm of cortical cells. Cells of different cortical zones are considered to represent different stages of adrenal cell aging: the zona glomerulosa serves as a cambial layer, the zona fasciculata consists of mature cells, and the zona reticularis contains aging and degenerating cells. Mitotic divisions are observed in the cells of the zona glomerulosa. The medulla is separated from the cortex by a thin layer of connective tissue.

The medulla consists of polygonal cells arranged in groups, between which lie thin connective tissue layers rich in capillaries. Granules in the cytoplasm of these cells stain yellow or brown with chromium salts, green with ferric chloride, and black with silver and osmium acid salts. Cells producing adrenaline are called adrenocytes (epinephrocytes), while noradrenaline-producing cells are termed noradrenocytes (norepinephrocytes). Noradrenocytes exhibit strong fluorescence under ultraviolet light and show argentophilic and iodine reactions. Adrenocytes stain with azocarmine, contain acid phosphatase, do not fluoresce, and do not react with iodine or silver. Noradrenocytes possess membrane-bound vesicles measuring 1000–30000 Å with highly electron-dense cores, whereas the vesicles of adrenocytes contain material of lower electron density [14].

The production of hormones by adrenal endocrinocytes with the participation of the hemomicrocirculatory system has been demonstrated [1].

Fibers of sympathetic and vagus nerves form a dense nerve plexus beneath the gland capsule. These fibers enter the gland while surrounding capillaries and sinusoidal veins. The medulla is

particularly rich in nerve elements. Preganglionic fibers of the sympathetic nerves terminate on adrenal cells. No parasympathetic elements are present in the medulla.

Aim of the Study. Currently, rabbit breeding plays an important role in meeting the demand for livestock products-especially dietary meat, fur, and woolin farms, dehkan households, and the private sector. Investigation of postnatal adaptive genesis in rabbits allows a deeper understanding of the mechanisms of postnatal adaptation and biological characteristics of the organism. This enables identification of specific anatomical and histological changes and contributes to accurate diagnosis, effective treatment, and prevention of diseases, taking into account the biological potential and ongoing morphophysiological processes in the animal body.

Therefore, the aim of this study was to investigate the anatomical and histological characteristics of the adrenal glands during postnatal ontogenesis in rabbits.

Place, Object, and Methods of Research. The scientific research was conducted in the laboratory and veterinary clinic of the Department of Animal Anatomy, Histology, and Pathological Anatomy of Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnology, as well as in the university vivarium, the Veterinary Research Institute, and private and farmer-owned rabbit farms of the region.

During clinical examinations, special attention was paid to the rabbits' appetite, body condition score, hair coat, and the color of mucous membranes. Body temperature, pulse rate per minute, and respiratory rate were recorded.

Experimental studies were carried out on rabbits of various breeds brought to the laboratory for anatomical and histological examination of the adrenal glands during postnatal ontogenesis. The study involved White Giant rabbits aged 1 and 21 days, as well as 1, 2, 3, 5, 8, 12, 24, and 36 months, with five animals in each age group. Housing and feeding conditions were standardized. Samples of the adrenal glands were collected from each rabbit for anatomical, histological, and laboratory analyses.

Research results and their analysis.

Table 1. Right adrenal gland of white giant rabbits

Age of the animal	Number of heads	Length, cm		Width, cm		Thickness, cm		Weight, g	
		M ± м	К	M ± м	К	M ± м	К	M ± м	К
1 day	5 ta	0,287±0,006	-	0,162±0,004	-	0,130±0,003	-	0,0034±0,0001	-
21 day	5 ta	0,455±0,005	1,59	0,239±0,003	1,48	0,171±0,002	1,31	0,009±0,0003	2,65
1 monthly	5 ta	0,573±0,011	1,26	0,342±0,005	1,43	0,214±0,002	1,25	0,025±0,0009	2,83
2 monthly	5 ta	0,635±0,006	1,11	0,413±0,010	1,21	0,259±0,003	1,21	0,069±0,002	2,73
3 monthly	5 ta	0,707±0,008	1,11	0,511±0,007	1,24	0,312±0,006	1,20	0,112±0,003	1,63
5 monthly	5 ta	1,066±0,016	1,51	0,624±0,008	1,22	0,407±0,006	1,30	0,181±0,003	1,61
8 monthly	5 ta	1,114±0,05	1,04	0,719±0,007	1,15	0,434±0,004	1,07	0,233±0,002	1,29
12 monthly	5 ta	1,241±0,014	1,11	0,755±0,009	1,05	0,456±0,007	1,05	0,256±0,004	1,10
24 monthly	5 ta	1,306±0,009	1,05	0,841±0,011	1,12	0,516±0,009	1,13	0,432±0,005	1,68
36 monthly	5 ta	1,422±0,021	1,09	1,020±0,011	1,21	0,519±0,007	1,01	0,526±0,006	1,22
1 day -36 monthly	50 ta		4,96		6,31		3,99		156,55

Note: Confidence level (p≤0,05)

Table 2. Left adrenal gland of white giant rabbits

Age of the animal	Number of heads	Length, cm		Width, cm		Thickness, cm		Weight, g	
		M ± м	K	M ± м	K	M ± м	K	M ± м	K
1 day	5 ta	0,279±0,006	-	0,164±0,004	-	0,150±0,005	-	0,0042±0,0002	-
21 day	5 ta	0,442±0,005	1,59	0,266±0,003	1,62	0,174±0,003	1,16	0,013±0,0006	3
1 monthly	5 ta	0,569±0,006	1,29	0,352±0,007	1,32	0,268±0,003	1,54	0,032±0,001	2,56
2 monthly	5 ta	0,689±0,007	1,21	0,463±0,007	1,32	0,286±0,004	1,07	0,076±0,002	2,37
3 monthly	5 ta	0,713±0,008	1,03	0,545±0,008	1,18	0,322±0,006	1,12	0,116±0,003	1,51
5 monthly	5 ta	1,135±0,013	1,59	0,665±0,012	1,22	0,415±0,005	1,29	0,221±0,007	1,91
8 monthly	5 ta	1,154±0,011	1,02	0,772±0,008	1,16	0,442±0,005	1,07	0,241±0,003	1,09
12 monthly	5 ta	1,249±0,014	1,08	0,769±0,009	0,99	0,479±0,005	1,08	0,302±0,005	1,26
24 monthly	5 ta	1,356±0,014	1,09	0,857±0,012	1,11	0,581±0,006	1,21	0,471±0,005	1,56
36 monthly	5 ta	1,505±0,013	1,11	1,024±0,013	1,19	0,560±0,006	0,96	0,5664±0,008	1,20
1 day -36 monthly	50 ta		5,39		6,24		3,73		134,76

Note: Confidence level ($p \leq 0,05$)

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