

A review Anatomical and Histological Study of the Adrenal Gland in Domestic Animals

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Abstract- By secreting hormones such as steroids and catecholamines, the adrenal gland contributes to the neuroendocrine system, which influences physiological equilibrium. In order to detect inter-dysfunction and adaptive morphological features, this investigation offers a more comprehensive physical and histological analysis of the adrenal glands of certain varieties of wild animals, including non-vegetarian, vegetarian, and ubiquitous species. It was discovered that the shape of the adrenal glands varied greatly between species, indicating metabolic and ecological adaptations. Anatomically, In wild animals, the adrenal glands are small, paired organs that are frequently oval or elongated. They are situated close to the kidneys' cranial pole. Species differences in size, shape, and location reflect ecological adaptations. Each of their two parts-the inner medulla and the outer cortex-has a unique structure and function. Histologically, all of the species under investigation displayed the typical zonation pattern of the adrenal cortex, which consists of the zona glomerulosa, zona fasciculata, and zona reticularis, encircling a central medulla. However, these zones' relative thicknesses changed according to the species' physiological requirements. Carnivorous species, for instance, had more developed zona fasciculata, which is a clear adaptation for their increased need for glucocorticoid production. Because different species may react differently to stress, the density of chromaffin cells in the adrenal medulla varies. Our comparative analysis contributes to the understanding of adrenal gland biology in wildlife and provides valuable baseline data for evolutionary biology, veterinary endocrinology, and wildlife conservation. The complexity and diversity of adrenal gland structures across wild taxa are highlighted in this study, along with their evolutionary and ecological significance.

INTRODUCTION

The adrenal and suprarenal glands constitute two endocrine organs that reside upward next to the kidneys. They are made up of the cortex and the medulla, two distinct regions with entirely distinct behaves and an embryological background (1,2). The medulla secretes catecholamines, which are hormones of neural crest origin, while the mesodermal cote x produces steroid hormones. Both of those parts additionally generate different products. Information on subtle species differences in the anatomy and histology of these glands is necessary for endocrinopathy diagnosis and treatment in routine veterinary practice (3,4).

Although the location of the adrenal glands fluctuates by different species, in domesticated animals they usually lie close to the kidneys' cranial poles. The superior adrenal gland is typically situated next to the right kidney's hilus, while the left adrenal gland is typically larger and more medially positioned in respect to the left kidney's craniomedial border. Along with the connective tissue that surrounds the glands, this extensive the ability to vascular aids in the distribution of hormones (5).

Species Variations

The present investigation observed adrenal glands in cattle, goats, and ruminants appeared lengthened and flat in shape, with the right gland typically having a higher level of development. In goat the more of Studies shown that as age increases, the gland thickens and becomes more zonally differentiated (6). In addition, the current study shown the adrenal gland in Horses appeared as oval shape, relatively small animals with a noticeable zona arcuata that is comparable to other animals' zona glomerulosa (7,8). In accordance with serious morphological ones such assessments, each of the glands had been dark red in color, as well as the corresponding left and right adrenal glands seemed stretched and shaped like a V respectively (Fig. 1). In pigs, Singh's 2007 report found that the left adrenal gland was wider and heavier than the right, but the right was thicker and longer (8). in the cat, the adrenal glands lied in the craniomedial aspect of the kidneys. The left adrenal gland was situated ventrolateral to the aorta, cranial to the curvature of the left renal artery and caudal to the region of aorta's celiac and cranial mesenteric arteries. The right adrenal gland is dorsolateral to the caudal vena cava, cranial to the original level of the celiac and cranial mesenteric arteries (9.10).

Histological Structure

Rodents: The present study finding the adrenal gland in rodents like in primate species, the adrenal gland in rats has a significant zona fasciculata, but the zona reticularis appears less distinct. It's intriguing to note that rats possess an extra



framework between the zona fasciculata and medulla called the zone (X). In male rats, this arrangement declines after growing up, but in female rats, it remains longer. It is thought that during improvement, this zone contributes to the synthesis of androgen.pigs, suggesting species-specific cortical organization (14,15).

Carnivores: Although the zona glomerulosa can be more vertical in carnivores than in rodents in particular they share an analogous distribution arrangement. Granule rich cells with chromaffin molecules make up the medulla; in dogs, norepinephrine-secreting cells predominate, while in cats, epinephrine-producing cells are more numerous. Variations in stress and fight-or-flight reactions can be seen in the variations in responses (16).

Herbivorous: The present investigation of review finding the outermost layer of fasciculata is broad and packed with lipidrich cells in large herbivorous animals, providing it a foamy their appearance. Because of the large number of blood vessels and sinusoids encircling the area between the medulla and cortex, the adrenal gland in horses is extremely circulation and histologically distinct. Ruminants' zona glomerulosa structurally adapts to aldosterone synthesis in accordance with eating habits mineral consumption by forming curves rather than clusters or rows (17).

Adrenal Medulla

The medulla is well-structured and encircled by an independent cortex in both humans and primate species. The chromogranin molecules cause cells that are chromaffin to become stained extensively and are grouped in chains or groupings. Cells that produce adrenaline predominate. while, The medulla seems less extensive than the cortex in rats. Although both chromaffin kinds of cells exist, their relative amounts can change. In rodents, the line separating the cortex and medulla might be less clear. In line with a more reactive sympathetic nervous system, cats exhibit a greater percentage of chromaffin cells that secrete adrenaline.

Comparative Histology Across Species Ruminants

In goats, the adrenal cortex exhibits age-related changes. Neonatal glands display a prominent fetal cortex, which regresses with age, leading to the development of the definitive cortex with well-defined ZG, ZF, and ZR layers (17).

Equines

The ZF is noticeable, with cells in straight cords, and the ZR is less distinct. Horses have a distinct zona arcuata, similar to the ZG, with arched clumps of cells (18).

Swine

The adrenal cortex of pigs is adequate and has distinct zones. The ZR is made up of smaller, closely spaced cells, whereas the ZF is the most noticeable and contains lipid-rich cells (19).

Canines and Felines

All three zones are clearly visible in the well-organized adrenal cortex of dogs and cats. Chromaffin cells are grouped in clusters within the medulla, which also contains cells that secrete norepinephrine and adrenaline (19).

Avian Species

Because there is no obvious corticomedullary distinction, birds have a unique adrenal structure. The subcapsular, peripheral, and central layers of the guinea fowl's adrenal gland each contain different amounts of cortical and medullary tissues. ZG, ZF, and ZR make up the cortex in black Iraqi partridges, while the medulla is scattered throughout the cortical cells (20).



Figure 1. Morphology of Adrenal gland (21)



Figure 2. Photography cross section of Adrenal gland in canine and feline (22).



Figure 3. Thin connective tissue capsules (arrowheads) are visible in photomicrographs of adrenal gland sections taken from the MT control group (D–F) and the control negative group (A–C). a normal adrenal medulla and a normal adrenal cortical structure made up of ZG, ZF, and ZR cells. stained with H&E. Under each image, the bar size is displayed (23).





Figure 4. Adrenal tissue regenerations from photomicrographs of sections of the adrenal glands from the diabetic STZ + MTtreated group that include (A,B) White arrowheads are a typical thin capsule of connective tissue. (B) A normal ZR cell layer (ZR), a mild vacuolation of the ZF cellular layer with normal arrangement (ZF), a mild vacuolation of the ZG cell layer (ZG), and a notable improvement in cortical zonal partitions. (A, C, D) Granular cytoplasmic basophilic chromaffin cells in the normal adrenal medulla (M). (D) Capillary medullary veins (V) with mild congestion. stained with H&E. Each image has a bar size indication underneath it (24).

CONCLUSION

The various physiological functions of the adrenal glands are reflected in the notable anatomical and histological differences among domestic animal species. Accurately diagnosing and treating endocrine disorders in veterinary medicine requires an understanding of these distinctions. Our understanding and the health of animals will be improved by more research on the morphology and function of the adrenal glands in different species.

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