

Adrenal Glands Histological Structure in Brown Bear (*Ursus arctos*, Linnaeus, 1758)

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The adrenal glands exhibit species specific differences in the outer layer of the glandular parenchyma cortex where in ruminants, some laboratory animals and human the cells form glomeruli, but in carnivores, horse and pig they are arranged in arches. The purpose of this study was to examine histologically adrenal gland of a deceased adult male Brown bear during summer time and to compare its morphology with those of other domesticated animals and human. In our study we found endocrine cell clusters in the capsule of the gland which was described only in horse adrenal gland. We also established that in outer cortical zone of the adrenal glands parenchyma the cells form arches which resembled the shape and the height of the dog's glands. The remaining inner cortical zones and the medulla were situated similarly to those of the bovine, horse, pig, dog and human adrenal glands and did not show structural peculiarities.

Key words: adrenal glands, histology, bear

Introduction

The Brown bear (*Ursus arctos*, Linnaeus, 1758, subspecies *Ursus arctos arctos* distributed in Europe) belongs to class Mammalia, order Carnivora, family Ursidae, and it was classified as caniforms, or doglike carnivores [5, 7, 9]. According to the taxonomy the scientific name *Ursus arctos* of the Brown bear, comes from the Latin term “ursus” meaning bear, and from the Greek term for bear ἄρκτος (*arctos*) [20]. As a wild animal it consumes a great variety of foods and fish preferentially, but also supplements its diet with fruits, vegetables and mushrooms to 90% which is the cause bears to be classified as omnivorous animals [7, 19].

The Brown bear was subjected to various genetic and ecological studies of its origin and behavior [5, 8, 12, 17, 19, 20]. In our country there are little scientific reports that are related to clinical cases and bear raising or medical treatment and legislation [1, 6, 12, 13, 16]. Furthermore, there are less morphological investigations focusing

on the specific bear organs. Therefore, after investigation of the bear stomach in our previous studies [18], we continued our research on adrenal glands morphology.

The adrenal glands are paired organs and according position of the body they are situated in the cranial topographic area of kidneys in most mammals, but in human they are in suprarenal site [9, 14]. Histologically the glandular parenchyma is composed of an outer part – cortex, derived from intermediate mesoderm and an inner or central part – medulla, derived from neural crest ectoderm. A solid capsule of a dense irregular fibrous connective tissue envelops the organ. Delicate trabeculae of loose connective tissue arising from the capsule and bringing blood vessels and preganglionic sympathetic axons, sparse the parenchyma and also form fragile membrane-like coat between cortex and medulla. The adrenal cortex architecture shows three zones which the outermost is *zona glomerulosa* (syn. *arcuata*), then the consecutive is *zona fasciculata* and the innermost is *zona reticularis*. The first zona constitutes the outer cortex and the latter two zones form the inner cortex. In some animals like uniungulates, carnivores, but usually not in ruminants, between the outer and the inner cortex exists a narrow band of polymorphic undifferentiated cells forming additional the *zona intermedia* [2, 3, 4, 10, 11, 15].

The purpose of this study was to examine histologically adrenal glands of the brown bear (*Ursus arctos*, Linnaeus, 1758) and to compare its morphology with those of other domesticated mammalian species – cattle, pig, horse, dog and comparatively with human.

Materials and Methods

The examined animal was a 32 years old, male Brown bear (*Ursus arctos*, Linnaeus, 1758) with body weight of approximately 160 kg, deceased at the The Dancing Bears Park near by Belica town, Bulgaria. The bear was autopsied at the Faculty of Veterinary medicine, University of Forestry, Sofia in summer 2019 and samples from the internal organs were collected for examination. The death was caused by a trauma received as a result of a tragic accident. The animal had no anamnestic data of other chronic illness or pathology.

Histological sections of bear adrenal gland with 7-8 μm thickness were prepared using the conventional method of formalin fixed paraffin embedded tissue [18]. After staining with hematoxylin and eosin, the slides were observed, examined and measured under light microscope Olympus, Cx 21FS1, (China) in form of optical and computerized system and finally recorded with photcamera Olympus C5050 (Japan).

Results and Discussion

Starting the investigation of the bear adrenal glands' structure, firstly the capsule was measured. Its thickness was $300\pm 10 \mu\text{m}$, consisted of dense irregular connective tissue layer, where clusters of endocrine polymorphic cells were found (**Fig. 1**). The same morphological characteristic was only described in the horse adrenal gland capsule [3]. The capsule of the bear adrenal gland was found to be the thickest of all investigated animal species glands and also the man.

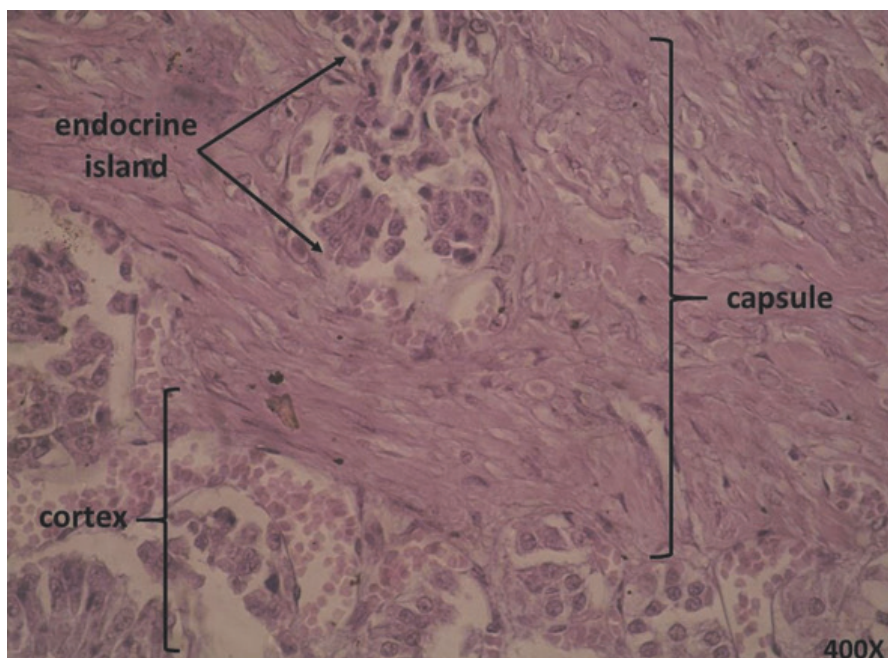


Fig. 1. Adrenal gland periphery, *Ursus arctos*. H&E.

Our study demonstrated that in the brown bear as an omnivorous animal, the outer cortical zone (za) of the adrenal gland represented arcuate type and the curves had similar shape and height as in the dog (**Fig. 2**). Arranged as arches of columnar cells, the arcuate zone (za) is the source of mineralocorticoids (aldosterone and corticosterone). The observed endocrinocytes were bipolar cells with lipid droplets at both poles. Arising from zona intermedia, the arcuate cells are differentiated and, in turn, undergo apoptosis [2, 9]. In comparison the arches are best presented in horse's, then in dog's and least demonstrated in pig's adrenal glands (**Fig. 3**).

The cells found in the fasciculate zone (zf), which produce glucocorticoids (cortisol and cortisone) were spherical, separated by sinusoids and bundled as fascicles. The reticular zone (zr) was constructed by polyhedral cells, excreting androgens, arranged in frame of anastomosing cords and plates, splitted up by large sinusoids. The intermediate zone (zi) which is established in horse adrenal gland in the examined samples from brown bear was not apparent and non-differentiated polymorphic cells were not observed.

For the purposes of comparison, bovine and human adrenal glands were also examined (**Fig. 4**). In the outer cortex *zona glomerulosa* was visible and cells arranged in convoluted and globular formations were easily differentiated. The inner cortex, which consists of two zones- fasciculate and reticular respectively, the community of cells had typical histological organization in bundles and network respectively, as described by other authors [3, 4, 11, 15].

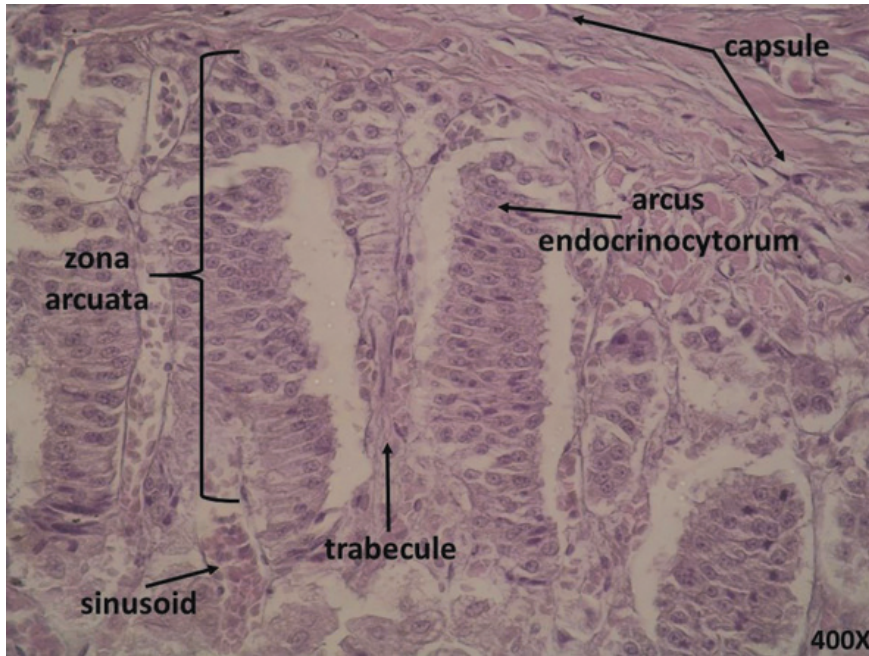


Fig. 2. Outer cortex of adrenal gland, *Ursus arctos*. H&E.

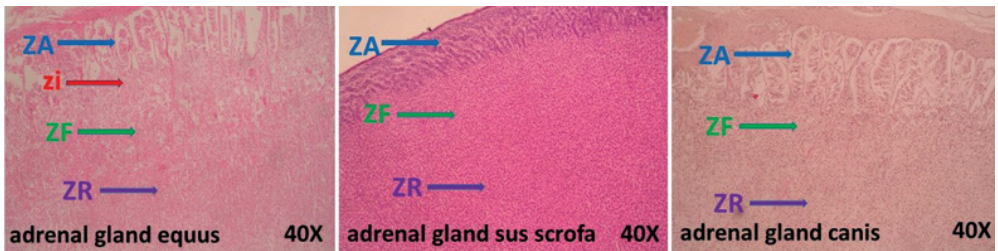


Fig. 3. Cortical zones of adrenal glands in domesticated animal species. H&E.

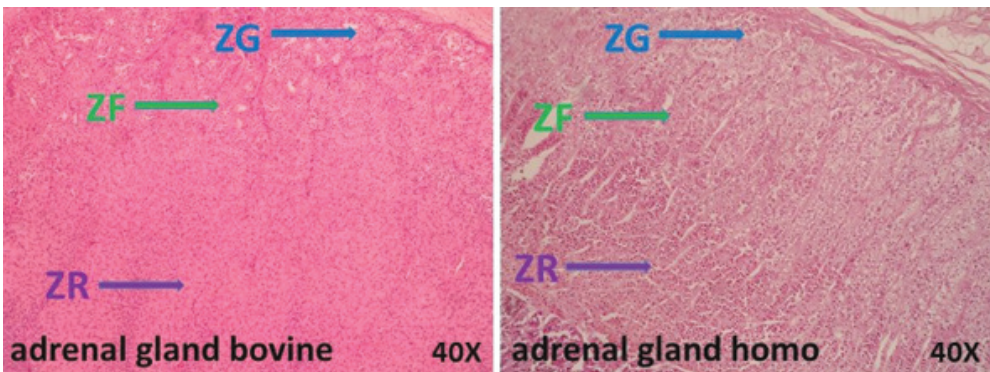


Fig. 4. Cortical zone of adrenal glands in large ruminant and human. H&E.

As norm, the medullary endocrinocytes (neuroendocrinocytes or chromaffin cells, secreting catecholamines) are derived from the embryonic ectodermal neural crests and are modified sympathetic neurons which lack axonal projections [2, 3, 4, 10, 15].

In our samples (Fig. 5) from brown bear's adrenal glands medulla were observed cells with classic characteristics of neuroendocrine cells too and granules were situated in poles. The endocrine cells were organized in the form of clusters (cl) separated by sinusoids (si), which were filled with blood cells. Some of the neuroendocrine cells in the parenchyma demonstrated lipid vacuolization (lv). Cells were of two types according to their specificity synthesizing epinephrine (adrenalin) or norepinephrine (noradrenalin). The epinephrocytes (epn) were larger and eosinophilic lighter rounded cells with euchromatic nucleus, while the norepinephrocytes (nep) observed were columnar cells with reddish darker cytoplasm and heterochromatic ellipsoidal nucleus.

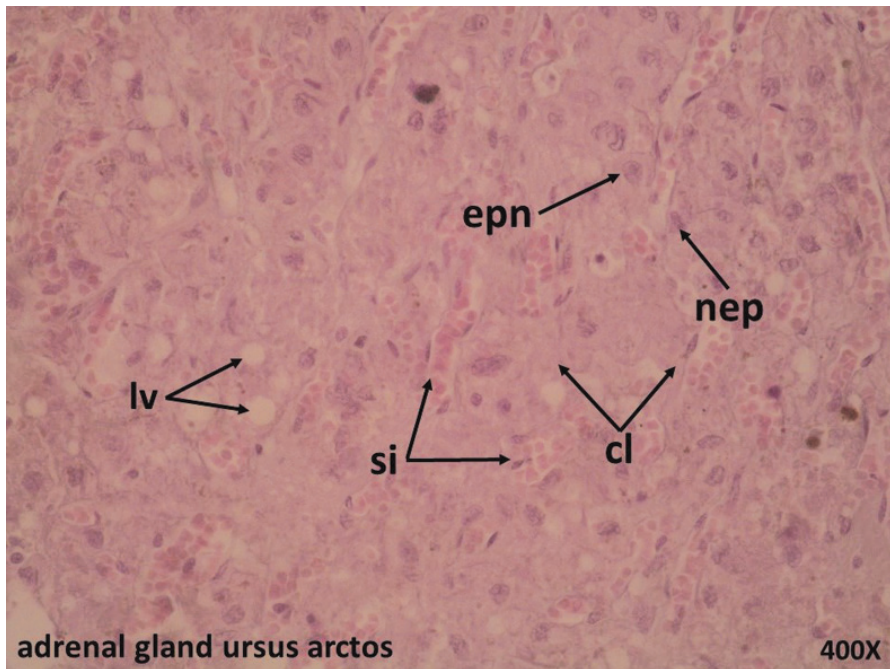


Fig. 5. Medulla of adrenal gland, *Ursus arctos*. H&E.

Conclusion

The adrenal glands in brown bear, as omnivorous mammal, have specificity in histological structure and differ from that one in human. The organ capsule was the thickest of all compared glands and presence of clusters of endocrine cells in it showed similar organization as in the horse. The arcuate zone in the outer parenchymal cortex and the alignment of endocrine cells, forming the curves was closer to dog's glandular histoarchitecture. The rest of the parenchymal zones of the cortex and the medulla were identical to those of the bovine, horse, pig, dog and human adrenal glands and did not show morphological peculiarities in their structural arrangement.

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