Acta Veterinaria-Beograd 2024, 74 (2), 322-330
UDK: 599.742.21:616.441-006.5
DOI: 10.2478/acve-2024-0023

Case report

A POSTMORTEM FINDING OF A COLLOID GOITER IN AN AMERICAN BLACK BEAR *(URSUS AMERICANUS)*

Georgi Stoychev POPOV[1], Iliana Stefanova RUZHANOVA-GOSPODINOVA[2*], Konstantin Bogdanov AMINKOV[3], Georgi Ivanov GEORGIEV[2], Vasil Kostadinov MANOV[1]

[1]University of Forestry, Faculty of Veterinary Medicine, Department of Internal Noninfectious Diseases, Pathology and Pharmacology, Sofia, Bulgaria; [2]University of Forestry, Faculty of Veterinary Medicine, Department of Anatomy, Physiology and Animal Science, Sofia, Bulgaria; [3]University of Forestry, Faculty of Veterinary Medicine, Department of Surgery, Radiology, Obstetrics and Gynecology, Sofia, Bulgaria.

(Received 23 March, Accepted 07 June 2024)

The present case report aims to describe a postmortem finding of a colloid goiter, without obvious clinical signs of endocrine disease in a 30-year-old American black bear (*Ursus americanus*) from the "Zoo" in the city of Sofia, Bulgaria. A clinical examination due to a bad general condition was performed under anesthesia and a computed tomography was conducted. After the established irreversible spondylarthrosis changes the bear was euthanized. Postmortem, the thyroid gland was pathologically examined and typical findings for a colloid goiter were observed. Hibernating mammals such as the American black bear have been shown to enter a state of physiological hypothyroidism during hibernation. Hormonal signals from the thyroid gland have been suggested to be a key mediator of hibernation. From the presented case could be assumed that the captive life conditions and the prolonged life of the zoo bears may affect the function of their thyroid gland.

Keywords: American black bear, colloid goiter, computed tomography, thyroid gland, *Ursus americanus*

INTRODUCTION

The American black bear (*Ursus americanus*) is a medium-sized member of the bear family (*Ursidae*) that inhabits the forests of North America. It is an omnivorous animal, and the type of food varies depending on the season and territory of residence. The average survival in the wild is 18 years, while in captivity the oldest documented bear was 44 years old [1]. The American black bear has four main physiological states

*Corresponding author: e-mail: iliana_ruzhanova@ltu.bg

related to the annual seasons [2]. The first state is hibernation, which occurs between December and April, depending on the geographical region. The second is the so-called "walking hibernation", which occurs immediately after hibernation, and lasts from 1 to 3 weeks, during which the bears consume a limited amount of food and water. The third state is referred to as the animal's normal activity and usually lasts from May to September. The fourth state is a period of hyperphagia, during which the bears are in intensive caloric intake and consume large amounts of food. This condition lasts from September until the beginning of the hibernation phase. During hibernation, bears meet their energy needs mainly from the fat accumulated in the adipose tissue and slow down their metabolic rate by about 25% [3], compared to the period of normal activity. The phenomenon of hibernation is the subject of research by several scientists, and the processes that allow hibernating animals to survive and preserve their vital functions during this period are still being researched. In humans, thyroid hormones are the primary endocrine regulators of metabolic rate [4], leading scientists to research thyroid activity according to the stages of hibernation. Bears during hibernation are in a state of hypothyroidism and exhibit signs similar to those of hypothyroid humans such as slowed basal metabolic rate, bradycardia, hypothermia, constipation, and fatigue [5]. The same authors suggest that hypothyroidism itself is the key regulator of hibernation in bears. Cases of bears bred in captivity and not hibernating which developed clinical and morphological pathology of the thyroid gland were documented in the literature. A 14-year-old female American black bear kept in a zoo was diagnosed with thyroid cystadenoma, colloid goiter, and hypothyroidism by Storms et al., 2004 [6]. Similar changes were established also in a Grizzly bear (*Ursus horribilis*) [7].

The structure of the thyroid gland of animals is broadly researched macroscopically [8] and histologically [9]. Thyroid enlargement of a non-neoplastic and non-inflammatory nature ("goiter") can be observed in all domestic mammals, birds, and submammalian vertebrate species [10]. They can be congenital and acquired, as the latter is divided into hyperplastic, nodular, and colloid goiters. All these variations are associated with hypothyroid, hyperthyroid, and euthyroid states [11]. Thermogenesis is stimulated by different mechanisms, as the thyroid hormone plays an important role in it. It stimulates various biological processes involved in heat production, thus the thyroid hormone directly modulates thermogenesis [12].

The present case report describes the computed tomography and histopathological findings of the thyroid gland in a captive-bred American black bear from the "Zoo" in the city of Sofia.

CASE PRESENTATION

A 30-year-old, male, American black bear (*Ursus americanus*), with no reported clinical signs of thyroid disease, was examined under anesthesia due to the worsened general condition, expressed in food refusal, apathy, and lethargy. The animal was premedicated with a combination of intramuscular injection of tiletamine HCl and zolazepam HCl

(Zoletil 100® Virbac, France) at 1 mg/kg, medetomidine HCl (Sedin®, Vet Farma, Spain) at 0.003 mg/kg. Premedication was administered by distant sedation dart (TeleDart RD706 Westheim/Pfalz – Germany) and syringes (arrows) using a 1.2mm x 38mm needle and 10 ml syringes. A 16G (Introcan®-W Certo 16G, B. Braun Melsungen AG, Melsungen – Germany) intravenous catheter was placed in the cephalic vein. Anesthesia was induced using propofol (Norofol® Norbrook, Northern Ireland) at 2 mg/kg administered intravenously into the cephalic vein. The patient was intubated and ventilated with oxygen set at 5-6 L/min. During the computed tomography (CT) examination anesthesia was maintained using isoflurane (Isoflurin 1000®, Vetpharma Animal Health, S.L., Barcelona, Spain) at 2.0 vol/%. Computed tomography of the spine was conducted in a supine position at 10mm intervals and scan thickness of 1.5 mm. The examination was performed on a "Picker® CT PQ5000" computer tomograph and "DICOM Viewer"® computer software. Due to the established irreversible spondylarthrosis changes of the thoracolumbar and lumbosacral spine and the low life quality the bear was euthanized by intravenous administration of pentobarbital sodium (Euthasol® Virbac, California, United States) at 50 mg/kg. Postmortem, the bear's thyroid gland was pathologically examined. Macroscopic changes were photo-documented with a Lumix, DC-FZ82 (Panasonic, USA) camera. The pathohistological examination was performed according to the classical paraffin technique [13]. Gland samples were fixed in 10% buffered neutral formalin. The fixed materials were dehydrated in ascending alcohol series – 50, 60°, 70°, 80°, 90°, 96° and absolute alcohol for 3 hours in each concentration. After dehydration, the samples were cleared in xylene and embedded in paraffin blocks, which were cut with a rotary microtome, with a section thickness of 5 μm. The sections thus made were mounted on slides by histological glue, then again processed in xylene, dehydrated by passing through a descending alcohol series – absolute alcohol, 96°, 90°, 80°, 70°, 60°, 50° and stained with Hematoxylin-Eosin. Microscopic examination and photography were performed with a Levenhuk D740T light microscope and an integrated camera. The terms used to describe the anatomical and histological structure of the thyroid gland are consistent with Saber, 2018 (N.A.V., 2018) [8] and Seeger, 2017 (N.H.V., 2017) [9].

On the computed tomography scans the thyroid gland showed bilateral enlargement. It was observed from the caudal end of the axis to the cranial extremity of the 5th cervical vertebra (Figure 1). Linear measurements of the gland dimensions with the available software showed a length of 71 mm, width of 12mm, and height of 19 mm. The gland was established with hyperdense areas indicative of fibrosis and with hypodense oval cystic formations. (Figure 1). Unfortunately, no blood samples for thyroid hormone detection were taken. The subsequent pathological examination confirmed the bilateral enlargement of the thyroid gland. The lobes were diffusely enlarged (Figure 2A) with a pale pink, translucent macroscopic appearance. Pale, striated, variable-sized fibrous areas and colloid cysts of varying diameters were found on the cut surface (Figure 2B).

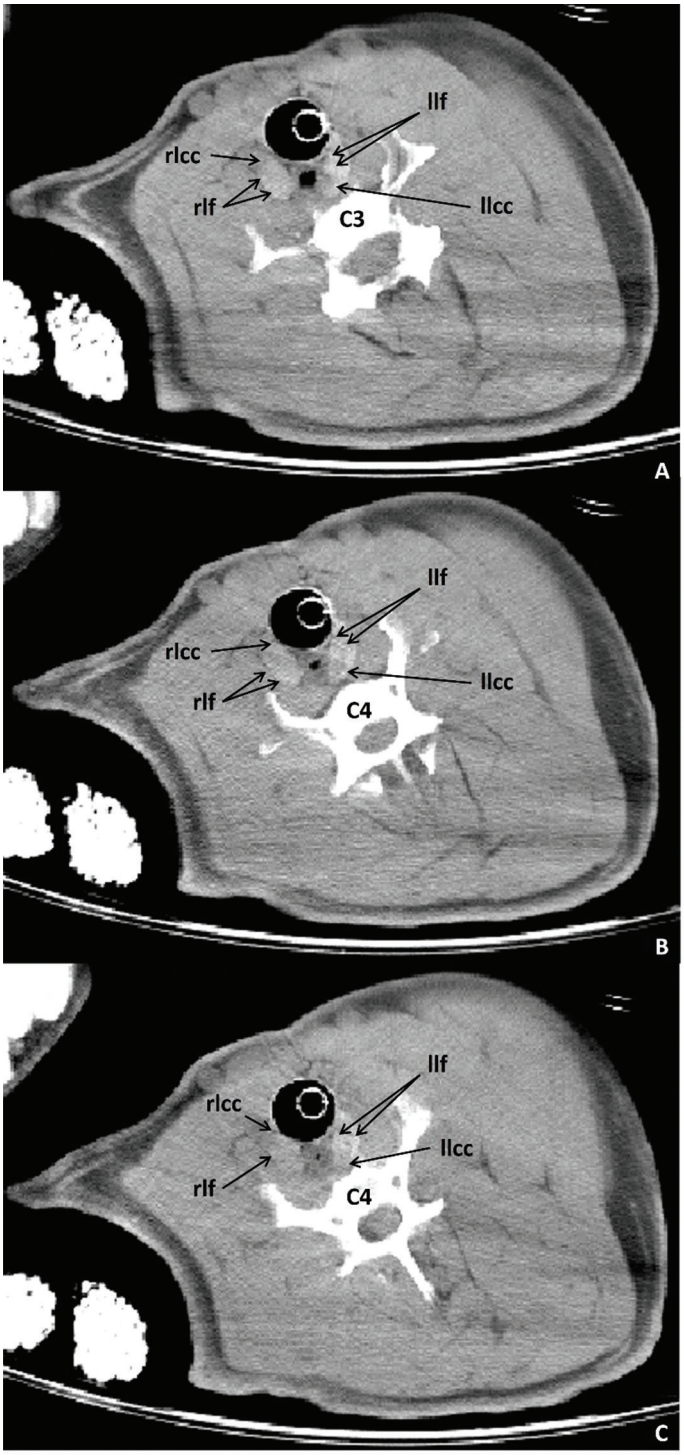

Figure 1. Computed tomography on the cervical region of the American black bear. **A.** CT section at the level of the caudal end of the third cervical vertebra (C3); **B.** CT section at the level of the cranial end of the fourth cervical vertebra (C4); **C.** CT section at the level of the caudal end of the fourth cervical vertebra (C4): rlcc – right lobe colloidal cyst, rlf – right lobe fibrosis, llcc – left lobe colloidal cyst, llf – left lobe fibrosis.

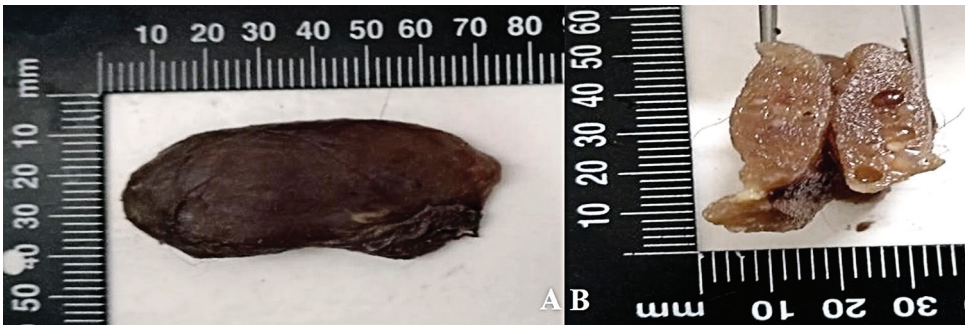

Figure 2. Enlarged thyroid gland of American black bear fixed in formaldehyde. **A.** Diffuse enlargement of the left thyroid lobe; **B.** Diffused enlargement of the right lobe of the gland with the presence of different-sized colloidal cysts on the cut surface.

The pathohistological findings included significantly enlarged follicles of the gland together with formed macro-follicles with accumulated dense eosinophilic colloid (Figure 3A). The acinar cells overlying the macro-follicles were described as flattened and atrophic (Figure 3B) and the boundary zone between the colloid and the luminal surface of the cells was smooth. A weak vascularization of the gland parenchyma was also observed on the histo-slides.

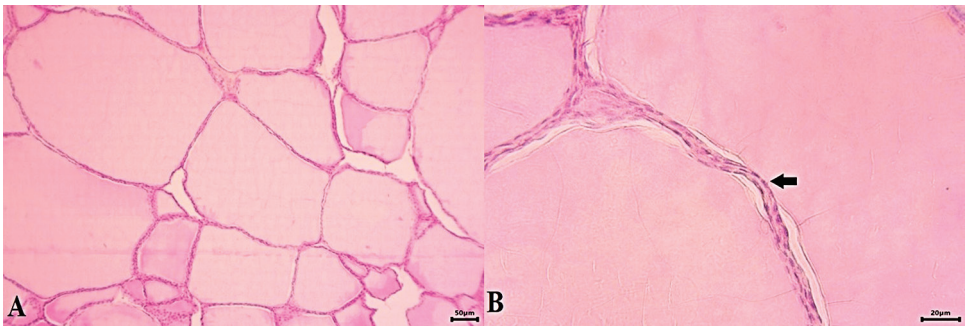

Figure 3. Colloid goiter in American black bear (H&E). **A.** Enlarged and colloid-filled thyroid follicles (x100); **B.** Flattened and atrophic follicular cells (arrow) lining the enlarged follicles (x400).

DISCUSSION

The normal CT appearance of the thyroid gland was broadly researched in humans [14,15], canines [16], and felines [17]. The described hyperattenuating to the surrounding tissue and homogenous view of the gland was not established in the present case report. Similar heterogeneous, X-ray appearance of thyroid lobes has been described in humans with inflammatory and non-inflammatory thyroid diseases, including colloid goiter. According to the literature data, the heterogenicity of the gland with colloid goiter is given by the solid extracellular matrix, colloid cysts, and sometimes the presence of calcification and fibrosis [15]. In our report fibrosis was identified around

the follicles, but no calcification was established. The macroscopic findings of the reported pathology were well documented in humans and domestic animals and are considered indicative of the diagnosis. One of the frequent causes of colloidal goiter development is iodine deficiency, which is typical in certain geographical areas. In these cases, the secretion of thyroid hormones is disturbed, which leads to an increased release of thyroid-stimulating factor, causing hypertrophy and hypersecretion of thyrocytes [18]. Colloid goiter is observed as the involutional phase of diffuse thyroid hyperplasia when thyroid hormone requirements have decreased in older animals [10]. Another potential cause is systemic ingestion of goitrogenic foods, such as kale, cabbage, broccoli, turnips, and other *Brassica* and *Crucifera* genera [11]. In the presented case this could not be considered as a reason for the established condition, because the animal lived in captive conditions at the zoo, where received a proper diet as close as possible to the one in the wild such as fruits, especially berries, hard masts and fish.

Regardless of the etiology, the present report describes macroscopically bilateral diffuse enlargement of the thyroid gland with a slightly transparent and bright appearance in contrast to hyperplastic enlargements, due to the lower degree of vascularization in colloid goiter and the macro-follicles formed by the involution and swelling of follicular acini by colloid. The microscopic findings correspond to the colloidal goiter described in domestic animals by various authors [10,18,19] and was a deviation from the normal histological structure of the granule gland described by Seeger, 2017 (N.H.V., 2017) [9]. The abnormality was also microscopically consistent with the one described by Storms et al. (2004) [6] in the American black bear. They reported a cystic adenoma of the thyroid gland together with the colloidal goiter, which was accompanied by hypothyroidism, while in the present case, no neoplastic pathology of the gland was established, as well as clinical signs of endocrine disease. Russel 1970 [7] describes similar hypothyroidism changes in a grizzly bear.

Due to the artificial environment, the year-round warm conditions in the bear sanctuaries, and the stress caused by the zoo visitors, bears kept in captivity do not usually hibernate during the winter period [6]. The similarity in husbandry, clinical, and pathological findings of the thyroid gland with those with diagnosed hypothyroidism gave the authors reason to suspect that the American black bear described in this report has the same endocrine disease. The cause of the colloidal goiter in the present case is undetermined. Due to the optimized nutritional regime in zoos, etiological factors related to nutrition and malnutrition can be excluded. The causes related to age changes and senility remain with greater potential. Since the lifespan of zoo-bred bears is significantly extended the authors recommend periodic monitoring of the morpho-functional state of the gland. On the other hand, the habitat and nutrition of captive bears should be as close as possible to their natural ones, and conditions for full hibernation should be maintained.

Acknowledgements

We thank Dr. Tanya Getova and Dr. Rosen Krastev, for their guidance and assistance in researching the bear, as well as the employees at the Sofia Zoo.

Authors' contributions

GP prepared and analyzed the histopathology microscopic samples and wrote the manuscript. IRG performed the autopsy, interpreted the data, and critically revised the manuscript. KA performed anesthesia and computed tomography of the bear. GG interpreted the CT data and contributed to the manuscript writing. VM updated the intellectual content and performed final approval.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ORCID iCD

Georgi Stoychev Popov https://orcid.org/0000-0001-6746-3753
Iliana Stefanova Ruzhanova-Gospodinova https://orcid.org/0000-0002-5855-9996
Konstantin Bogdanov Aminkov https://orcid.org/0000-0002-1992-5164
Georgi Ivanov Georgiev https://orcid.org/0000-0002-0948-6268
Vasil Kostadinov Manov https://orcid.org/0000-0001-9306-3665

REFERENCES

1. Brown G. Bear anatomy and physiology. In: *The Great Bear Almanac*. New York: Lyons & Burford, Publishers; 1993, 46-93.
2. Nelson R, Folk GJ, Pfeiffer E, Craighead J, Jonkel C, Steiger D: Behavior, biochemistry, and hibernation in black, grizzly, and polar bears. Bears: their biology and management 1983, 284-290.
3. Tøien Ø, Blake J, Edgar D, Grahn D, Heller H, Barnes B: Hibernation in black bears: independence of metabolic suppression from body temperature. Science 2011, 331:906-909.
4. McAninch E, Bianco A: Thyroid hormone signaling in energy homeostasis and energy metabolism. Ann N Y Acad Sci 2014, 1311:77-87.
5. Frøbert A, Nielsen C, Brohus C, Kindberg J, Fröbert O, Overgaard M: Hypothyroidism in hibernating brown bears. Thyroid Res 2023, 16:1-8.
6. Storms T, Beazley S, Schumacher J, Ramsay E: Thyroid cystadenoma, colloid goiter, and hypothyroidism in an American black bear (Ursus americanus). J Zoo Wildl Med 2004, 35(1):82-87.
7. Russell WC: Hypothyroidism in a grizzly bear. J Am Vet Med Assoc 1970, 1:157(5):656-62.

8. Saber S: Splanchnologia. In: *Constantinescu G*, *Illustrated veterinary anatomical nomenclature*, 4th edn, Theme Verlag KG, Stuttgart 2018, 231-233.
9. Seeger J: In: *Seeger J., Stofel M., Simoens P., (Ed.). Nomina Histologica Veterinaria*. Submitted by the International Committee on Veterinary Histological Nomenclature (ICVHN) to the World Association of Veterinary Anatomists 2017, 44.
10. Rosol T, Meuten D: Tumors of the endocrine glands. In: *Meuten D. (Ed.). Tumors in domestic animals*, 6th ed, John Wiley & Sons, Raleigh, North Carolina 2017, 766-833.
11. Jones T, Hunt R, King N: Endocrine glands. In: *Jones, T., R. Hunt, N. King (Ed.). Veterinary Pathology*, 6th ed. Williams and Wilkins, Philadelphia, Pennsylvania 1997, 1236–1240.
12. Silva JE: Thyroid Hormone Control of Thermogenesis and Energy Balance. Thyroid 1995, 5(6):481–492.
13. Bancroft J, Gamble M: Theory and practice of histological techniques. 6th ed. Edinburgh: Churchill Livingstone 2008, 174-186.
14. Weber AL, Randolph G, Aksoy FG: The thyroid and parathyroid glands. CT and MR imaging and correlation with pathology and clinical findings. Radiol Clin North Am 2000, 38(5):1105–1129.
15. Saeedan B, Aljohani I, Khushaim A, Bukhari S, Elnaas S: Thyroid computed tomography imaging: pictorial review of variable pathologies. Insights Imaging 2016, 7(4):601-17.
16. Taeymans O, Schwarz T, Duchateau L, Barberet V, Gielen I, Haskins M, Van Bree H, Saunders JH: Computed tomographic features of the normal canine thyroid gland. Vet Radiol Ultrasound 2008, 49(1), 13-19.
17. Drost WT, Mattoon JS, Samii VF, Weisbrode SE, Hoshaw-Woodard SL: Computed tomographic densitometry of normal feline thyroid glands. Vet Radiol Ultrasound 2004, 45(2), 112-116.
18. Manov V: General Veterinary Medicine Pathology (BG), Panev Publishing, Sofia; 2022, 21-57.
19. Miller M: Endocrine system. In: Zachary, J. (Ed.) Pathologic basis of veterinary disease, 6th ed, Elsevier Health Sciences, Urbana, Illinois; 2017, 682-723

POSTMORTEM NALAZ KOLOIDNE STRUME KOD AMERIČKOG CRNOG MEDVEDA *(URSUS AMERICANUS)*

Georgi Stoychev POPOV, Iliana Stefanova RUZHANOVA-GOSPODINOVA,
Konstantin Bogdanov AMINKOV, Georgi Ivanov GEORGIEV,
Vasil Kostadinov MANOV

Ovaj prikaz slučaja ima za cilj da opiše postmortalni nalaz koloidne strume, bez očiglednih kliničkih znakova endokrinog oboljenja kod 30-godišnjeg američkog crnog medveda (*Ursus americanus*) iz "Zoo vrta" u gradu Sofiji, Bugarska. Klinički pregled zbog lošeg opšteg stanja urađen je pod anestezijom prilikom čega je urađena kompjuterska tomografija. Nakon utvrđenih ireverzibilnih spondiloartroznih promena, medved je eutanaziran. Postmortalno, tiroidna žlezda je pregledana i uočeni su tipični nalazi za koloidnu strumu. Pokazalo se da sisari koji hiberniraju, kao što je američki

crni medved, ulaze u stanje fiziološke hipotireoze tokom hibernacije. Smatra se da su hormonski signali iz štitne žlezde ključni posrednik hibernacije. Iz prikazanog slučaja moglo bi se pretpostaviti da uslovi života u zatočeništvu i produženi život medveda u zoološkom vrtu mogu uticati na funkciju štitne žlezde.