

The Armed Forces Institute of Pathology  
Department of Veterinary Pathology  
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CONFERENCE 20  
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**CASE I** – 04-2782 (AFIP 2984018).

**Signalment:** Male, Labrador Retriever, 9 yrs, canine.

**History:** The dog had an eleven month history of dermatitis. The footpads were hyperkeratotic, inflamed, and painful with multiple pustules. There was severe hyperpigmentation on the ventral abdomen and an overall greasy haircoat. Multiple areas of crusting, alopecia, and erythema, with multiple bacterial agents were seen by cytology. The infections were resistant to treatment and topical treatment was finally discontinued due to the pain associated with the treatments. Originally he responded to parental amino acid infusions. He was euthanized at the owner's request.

**Gross Pathology:** The body was in poor post-mortem condition with advanced autolysis and a body condition score of approximately 1.5/5. The skin showed multifocal, widespread alopecia with erosion, ulceration, greasy covering and crust formation. In the lungs mild, acute diffuse, alveolar edema and emphysema as well as mild, acute congestion was present. The liver was approximately normal size with diffusely dispersed small nodules (approximately 0.5x0.5x0.5 cm to 1.0x1.0x1.0 cm) and of firm consistency. In the cortices of both kidneys a mild, grey, radial striation was present.

**Laboratory Results:** Multiple skin cultures revealing *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus/intermedius*, *Beta streptococcus* and others.

Significant lab data included: ALT 188 IU/L (reference range 10-55), ALP 307 IU/L (reference range 15-120), Bile Acids 98 Umol/L (reference range 5-20)

**Histopathologic Description:** The specimen is lip. The skin surface has diffuse marked acanthosis, parakeratotic hyperkeratosis and hydropic degeneration of the stratum spinosum with focal epidermal ulceration, suppuration and intralesional coccoid bacteria. Also in the skin, there is moderate to marked widespread pigmentary incontinence, mild dermal edema, mild dermal fibrosis, and mild superficial perivascular lymphoplasmacytic dermatitis. The stratum basale has marked hyperplasia and mild interstitial edema with occasional apoptotic cells. The mucosa and submucosa of the lip have similar changes (minus the hyperkeratosis) but they are less severe.

**Contributor's Morphologic Diagnosis:** Skin of Lip: Diffuse marked acanthosis, parakeratotic hyperkeratosis and hydropic degeneration of the stratum spinosum with focal epidermal ulceration and suppuration with intralesional coccoid bacteria.

**Contributor's Comment:** The histopathologic lesions in the skin are characteristic of hepatocutaneous syndrome. Hepatocutaneous syndrome is a generalized metabolic disorder that results in very characteristic "red, white and blue" skin lesions histopathologically formed by a hyperplastic basal cell layer, intracellular edema and necrosis of keratinocytes in the stratum spinosum, and marked parakeratotic hyperkeratosis.<sup>1-5</sup> In addition, there may be macules and papules as well as melanin incontinence.<sup>1,3,5</sup> These cases are presented clinically for crusty skin lesions on footpads, mucocutaneous junctions, ears, periorbital region and pressure points.<sup>1-5</sup> Pruritis may or may not be present as the result of secondary bacterial infections.<sup>1-5</sup> Anorexia, weight loss and lethargy may also be present.<sup>1-5</sup>

The underlying cause of the skin lesions in canines is most often idiopathic hepatopathy, although a similar disease in humans is most often the result of a glucagon-secreting tumor.<sup>1-5</sup> In most cases of hepatocutaneous syndrome the liver is small with nodular lesions surrounded by the collapse of the adjacent parenchyma.<sup>1-5</sup> The liver lesions in this case were characterized by periportal bridging fibrosis with biliary hyperplasia causing pseudolobulation of the liver. The pathogenesis of the skin lesions is unknown but may be related to hepatic dysfunction leading to elevated glucagon levels (due to decreased hepatic metabolism), decreased levels of amino acids (from increased gluconeogenesis), or disturbance of zinc metabolism (possibly a result of malabsorption).<sup>1-5</sup> Administration of amino acid supplements, high-quality protein diets or zinc may be helpful, however long-term prognosis is poor.<sup>1,2,4,5</sup>

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**AFIP Diagnosis:** Mucocutaneous junction, lip: Hyperkeratosis, parakeratotic, diffuse, marked, with acanthosis, edema of the stratum spinosum, basal cell hyperplasia, pigmentary incontinence, moderate diffuse lymphoplasmacytic

dermatitis, focal ulcer with pyogranulomatous inflammation, and surface bacteria, Labrador Retriever (*Canis familiaris*), canine.

**Conference Comment:** The contributor provides a concise summary of hepatocutaneous syndrome in the dog to include typical gross and histopathologic findings as well as potential causes and associated poor prognosis. Synonyms for the syndrome include metabolic epidermal necrosis (MEN), superficial necrolytic dermatitis (SND), and necrolytic migratory erythema (NME) in humans.<sup>1</sup>

As pointed out by the contributor, most cases of hepatocutaneous syndrome in the dog are associated with a hepatopathy. Hepatocutaneous syndrome can also be associated with diabetes mellitus and, less commonly, with a glucagon secreting tumor. The most common clinical dermatologic lesion is severe hyperkeratosis and deep fissuring of the footpads. The typical light microscopic finding in the liver is severe vacuolar degeneration with diffuse parenchymal collapse, condensation of reticulin, and nodular regeneration. Abdominal ultrasound of the liver reveals the unique and pathognomonic “honeycomb” pattern seen with SND.<sup>1,2,3,7</sup>

Hepatocutaneous syndrome has also been reported in cats and the black rhinoceros. Of the few cases of hepatocutaneous syndrome reported in cats, one was associated with pancreatic carcinoma, another with thymic amyloidosis, and four cases were associated with hepatopathy. Hepatocutaneous syndrome occurs in up to 50% of captive black rhinoceroses and is not associated with underlying metabolic disease. Interestingly, in the black rhinoceros, stressful events and/or dietary insufficiency leading to disruption of metabolic homeostasis is suspected as the basis for these skin lesions.<sup>1,4,6,7</sup>

The differential diagnosis includes other parakeratotic diseases such as zinc-responsive dermatosis, thallium toxicosis, lethal acrodermatitis of Bull Terriers, *Sarcoptes scabiei*, and generic dog food dermatosis. The clinical differential diagnosis includes pemphigus foliaceus, demodicosis, dermatophytosis, bacterial folliculitis, toxic epidermal necrolysis, systemic lupus erythematosus, and contact-irritant dermatitis. Most of these can be ruled out by appropriate historical, physical examination, clinical laboratory, and histopathologic findings.<sup>1</sup>

**Contributor:** <http://vet.osu.edu/biosciences.htm>

**References:**

1. Byrne KP: Metabolic epidermal necrosis-hepatocutaneous syndrome. Vet Clin North Am:Sm Anim Pract 29(6):1337-1335, 1999
2. Ghisleni G, Nageli-Schenker C, Caniatti M: Symmetrical crusting rash in a dog. Vet Clin Pathol 32(1):19-21, 2003

3. Jacobson LS, Kirberger RM, Nesbit JW: Hepatic ultrasonography and pathological findings in dogs with hepatocutaneous syndrome: new concepts. J Vet Intern Med 9(6):399-404, 1995
  4. Kimmel SE, Christiansen W, Byrne KP: Clinicopathological, ultrasonographic, and histopathologic findings of superficial necrolytic dermatitis with hepatopathy in a cat. J Am Anim Hosp Assoc 39:23-27, 2003. Available at <http://www.jaaha.org.proxy.lib.ohio-state.edu>
  5. Turek MM: Cutaneous paraneoplastic syndromes in dogs and cats: a review of the literature. Vet Dermatol 14(6):279-296, 2003. Available at <http://www.blackwell-synergy.com>
  6. Munson L, Koehler JW, Wilkinson JE, Miller RE: Vesicular and ulcerative dermatopathy resembling superficial necrolytic dermatitis in captive black rhinoceroses (*Diceros bicornis*). Vet Pathol 35:31-42, 1998
  7. Gross TL, Ihrke PJ, Walder EJ, Affolter VK: Skin Diseases of the Dog and Cat, 2nd ed., pp. 86-91. Blackwell Publishing Professional, Ames, Iowa, 2005
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**CASE II** – 05.16743 (AFIP 3026815).

**Signalment:** 10-year-old, spayed female, mixed breed dog, *Canis familiaris*.

**History:** The animal presented with a 3-4 week history of abnormal mentation, circling to the right, inappropriate urination/defecation, lethargy and weight loss. On neurological exam, the animal exhibited difficulty navigating in low light intensity and had decreased pupillary light reflexes.

**Gross Pathology:** A large, yellow-grey, moderately firm to soft, expansile, well demarcated mass measuring 1.6x 2x 3.3 cm is present within the third ventricle with extension into both the mesencephalic aqueduct and the fourth ventricle. Multifocally, small red-brown areas of hemorrhage are also noticed within the mass. The mass extended dorso-laterally into the adjacent neural parenchyma with compression and partial effacement of the corpus callosum, thalamus and midbrain. There is mild bilateral dilation (hydrocephalus) of the lateral ventricles.

**Laboratory Results:** Magnetic resonance imaging (MRI) of the brain revealed a large, irregular, well demarcated, midline contrast-enhancing mass arising from the third ventricle with mass effect on the surrounding parenchyma and bilateral ventriculomegaly.

**Histopathologic Description:** Depending upon the section examined, the unencapsulated intraventricular neoplasm is mostly well demarcated, expands the third ventricle, mesencephalic aqueduct and fourth ventricle and occasionally extends into adjacent neural parenchyma. The neoplasm is moderately to densely cellular and well vascularized. Neoplastic cells are arranged in sheets, clusters or fascicles and are moderately pleomorphic with indistinct cell borders and fibrillar eosinophilic cytoplasm. Nuclei are round to oval, with a hyperchromatic to coarsely granular chromatic pattern and prominent nucleolus in some. Mitotic figures are 2 per 10 40X objective fields. Pseudorosettes are common, as are foci of necrosis with peripheral palisades of neoplastic cells. Acute and chronic hemorrhage and perivascular aggregates of lymphocytes are also present.

**Contributor's Morphologic Diagnosis:** Brain: Ependymoma

**Contributor's Comment:** On the basis of histological features of prominent perivascular pseudorosettes, ependymoma, papillary meningioma and paraganglioma were considered as differential diagnoses. Immunohistochemical stains were performed for Vimentin, Pankeratin, GFAP and S100 (TUFTS-New England Medical Center). The neoplastic cells were negative for Pankeratin, showed mild variable cytoplasmic positive staining for S100 and diffuse, intense cytoplasmic staining for Vimentin. There was mild to moderate, variable (involving one-third of the mass) cytoplasmic positive staining for GFAP. The features of the neoplasm were most consistent with anaplastic ependymoma.

Ependymoma is an uncommon neoplasm originating from the ependymal lining of the ventricles of the brain and central canal of the spinal cord. In animals, intracranial ependymomas involving the lateral ventricles and less commonly the third and fourth ventricles have been reported in rats, cats, dogs, non-human primates, cattle, horses, deer, and fish. Rare cases of intraspinal ependymoma have also been described in animals.<sup>2,3,4</sup> In humans, this neoplasm is more common in the spinal canal and fourth ventricle rather than the lateral ventricles. Rare instances of ectopic ependymomas involving the presacral or postsacral soft tissue as well as intracranial tumors far removed from the ventricular system are documented in humans.<sup>1</sup> These tumors are usually slow-growing, can be well demarcated and confined within the ventricular system or in anaplastic variants can be highly infiltrative into the surrounding parenchyma and metastasize via the cerebrospinal fluid. Additionally, these tumors often cause concomitant compression of the adjacent neuropil and secondary hydrocephalus. Histologically, these tumors are characterized by distinct ependymal rosettes and perivascular pseudorosettes. Malignant forms exhibit marked necrosis, hemorrhage, focal infiltrative growth, together with moderate cellular atypia and marked mitotic activity. Ultrastructurally, ependymal cells have intercellular tight junctions or microvilli that project into the lumen or interdigitate between cells. Some of the

ependymal cells may be ciliated and contain cytoskeletal ciliary basal bodies (blepharoplasts). In some tumors, blepharoplasts can be visualized with phosphotungstic acid hematoxylin (PTAH). Immunohistochemically, ependymomas are variably stained for vimentin, GFAP, and cytokeratin. Canine ependymomas are frequently GFAP negative whereas the neoplasm in humans, cats and horses usually exhibits positive staining for GFAP. Mild to moderate positive staining is noted with vimentin and cytokeratin in all species.<sup>1,2,3,4</sup>

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**AFIP Diagnosis:** Brain, at the level of the hippocampus: Ependymoma, mixed breed (*Canis familiaris*), canine.

**Conference Comment:** The contributor provides a thorough overview of ependymomas to include behavior, histomorphologic features, and ultrastructural features. Grossly, ependymomas are usually large expansile intraventricular masses with generally well-demarcated margins. The neoplasm is gray to red, if hemorrhagic. More aggressive tumors infiltrate into normal tissue at its margins. As pointed out by the contributor, secondary obstructive hydrocephalus is common. Canine ependymomas have a smooth texture on cut surface while feline ependymomas are more granular.<sup>3,5,6,7</sup>

The differential diagnosis considered included astrocytoma, primitive neuroectodermal tumor, papillary meningioma, choroid plexus tumor and paraganglioma. Astrocytomas usually blend with the adjacent neuropil and do not form rosettes or pseudorosettes. Primitive neuroectodermal tumors are composed of small, primitive-appearing, round to carrot-shaped cells and usually have a high mitotic index. This neoplasm was not papillary, ruling out papillary meningioma. Choroid plexus tumors stain positively for cytokeratin and have a fibrovascular stroma versus the GFAP-positive glial processes that abut the vasculature in ependymomas. Paragangliomas display neuroendocrine packeting, which was not present in this case.<sup>3,7</sup>

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**References:**

1. Burger PC, Scheithauer BW: Tumors of the Central Nervous System, 3rd series fascicle 10, pp. 120-133. Armed Forces Institute of Pathology, Washington, D.C., 1994
2. Carrigan MJ, Higgins RJ, Carlson GP, Naydan DK: Equine papillary ependymoma. Vet Pathol 33:77-80, 1996

3. Koestner A, Higgins RJ: Tumors in Domestic animals, ed. Meuten DJ, 4th ed., pp. 707-709. Iowa State Press, Ames, Iowa, 2002
  4. Michimae Y, Morita T, Sunagawa Y, Sawada M, Okamoto Y, Shimada A: Anaplastic ependymoma in the spinal cord of a maltese dog. J Vet Med Sci 66(9): 1155-1158 2004
  5. Summers BA, Cummings JF, de Lahunta A: Veterinary Neuropathology, p. 375. Mosby-Year Book, Inc., St. Louis, Missouri, 1995
  6. Zachary JF: Nervous system. In: Pathologic Basis of Veterinary Disease, eds. McGavin MD, Zachary JF, 4th ed., p. 950. Mosby Elsevier, St. Louis, Missouri, 2007
  7. Koestner A, Bilzer T, Fatzer R, Schulman FY, Summers BA, Van Winkle TJ: Histological Classification of Tumors of the Nervous System of Domestic Animals, 2nd series, vol. V, pp. 17-19, 22, 25. Armed Forces Institute of Pathology, Washington, D.C., 1999
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**CASE III** – 05N658C (AFIP 3026835).

**Signalment:** 12-year-old male Avian Sulphur-crested Cockatoo (*Cacatua galerita*).

**History:** Not acting normal the last few days, staying “fluffed”. Died suddenly this a.m.

**Gross Pathology:** A 12 year old male cockatoo weighs 553.8 g and is in good nutritional body condition. There is edematous fluid within the subcutis over the ventral coelomic cavity and within the coelom (approximately 3 mls of clear fluid). A small amount of clear fluid is also within the pericardial sac and the lungs are edematous. There is blunting of the choanal papillae. The spleen is markedly enlarged (approximately 1 cm in diameter).

**Histopathologic Description:** Sections of brain, lung, intestines, liver, kidney, proventriculus, pancreas, small intestines, crop, heart, spleen, skeletal muscle, testis, adrenal gland and ventriculus are examined.

In sections of lung, tertiary or parabronchi as well as air capillaries contain homogenous eosinophilic material (serofibrinous exudate). Air capillary walls are markedly thickened and there is multifocal necrosis. Frequently groups of intracellular organisms, either banana shaped merozoites or small aggregates forming cysts, are in air capillary endothelial cells throughout the parenchyma. Mild perivascular infiltrates of lymphocytes and plasma cells are also noted.

In liver sections there is a moderate increase in lymphocytes and plasma cells throughout sinusoids. Kupffer cells are also increased and usually contain phagocytized cellular debris. There is mild scattered hepatocellular degeneration.

In the spleen there is a marked increase in lymphocytes and plasma cells throughout the parenchyma and numerous histiocytes contain phagocytized necrotic cellular debris. There is also widespread necrosis with karyorrhexis.

Significant lesions are not observed in other tissues examined.

**Contributor's Morphologic Diagnoses:**

1. Lung, interstitial pneumonia with serofibrinous exudation and intracellular protozoal merozoites
2. Liver, moderate, diffuse, lymphoplasmacytic hepatitis
3. Spleen, moderate, diffuse, lymphoplasmacytic and histiocytic splenitis with necrosis

**Contributor's Comment:** Pulmonary Sarcocystosis is a hyperacute disease and birds are usually found dead without any prior clinical signs. Due to the acute nature of the disease, affected birds are usually in good nutritional body condition. The most consistent gross lesion on necropsy is pulmonary edema. Liver and spleen can also be enlarged. Microscopically, lungs are congested and there is fibrin deposition, edema and hemorrhage. Lymphocytes and plasma cells accumulate around blood vessels and bronchi. Aggregates of organisms (small elliptical or crescent shaped) are in pulmonary endothelial cells.<sup>1</sup> Often organisms conform to the shape of the vessel. Light microscopy alone cannot accurately identify the organism. Differentials include *Neospora* and *Toxoplasma*. Immunohistochemistry and electron microscopy can be used to establish a specific disease agent. A definitive diagnosis of *Sarcocystis falcatula*-like pneumonia is not established in this case but that is considered the most likely based on lesions seen. Recent work suggests that substrains of *S. falcatula* may exist.<sup>2,3</sup>

*Sarcocystis* spp. are obligate two-life cycle coccidia. In North America the Virginia opossum (*Didelphis virginiana*) is listed as the definitive host. Intermediate hosts include various orders of birds. Old World psittacines develop more severe disease than New World psittacines and this is thought to be due to possible co-habiting with the definitive host.

Sarcocysts are ingested by the definitive host. Sexual reproduction occurs and infective sporulated sporocysts are excreted. The intermediate host ingests sporocysts and sporozoites are released and invade the host's gut. Asexual reproduction occurs in endothelial cells and parenchymal cells in various organs. Merozoites are produced which form sarcocysts in skeletal muscle.<sup>4</sup>



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**AFIP Diagnosis:** Lung: Pneumonia, interstitial, histiocytic and plasmacytic, diffuse, mild to moderate, with edema, necrosis, and intraendothelial sarcocysts, Sulphur-crested Cockatoo (*Cacatua galerita*), avian.

**Conference Comment:** The contributor provides an excellent overview of pulmonary sarcocystosis. Although sarcocysts also occur in skeletal muscle and the heart, the primary target in birds is the lung. Affected birds die acutely, although the presence of lymphocytes and plasma cells surrounding blood vessels and bronchi suggests the infection is subacute. As pointed out by the contributor, the opossum is the definitive host.<sup>1,2</sup>

While *T. gondii* should be considered, *S. falcatula* schizonts, unlike those of *T. gondii*, are located in endothelial cells and follow the shape of capillaries appearing tortuous with high variability in their size as seen in this case. Additionally, toxoplasmosis occurs infrequently in birds, is generally associated with more necrosis than seen in this case, has intrahistiocytic zoites, and has a wider tissue tropism. Ultrastructurally, *Sarcocystis* spp., unlike *T. gondii*, are not located within a parasitophorous vacuole and merozoites lack rhoptries.

*Atoxoplasma* sp., another protozoa that infects birds, is very difficult to see on H&E stained sections. Tiny merozoite-like stages of *Atoxoplasma* sp. have been found in the intestine and other tissues of birds. Some appear to be intracellular and others extracellular.

Natural infection with *Neospora caninum* has not been reported in birds.<sup>2,5</sup>

This case was reviewed in consultation with the AFIP Department of Infectious Diseases and Dr. Chris Gardiner.

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**References:**

1. Schmidt RE, Reavill DR, Phalen DN: Pathology of Pet and Aviary Birds, pp.29-30. Iowa State Press, Ames, Iowa, 2003
2. Dubey JP, Garner MM, Stetter MD, Marsh AE, Barr BC: Acute *Sarcocystis falcatula*-like infection in a carmine bee-eater (*Merops nubicus*) and immunohistochemical cross reactivity between *Sarcocystis falcatula* and *Sarcocystis neurona*. J Parasitol 87:824-832, 2001

3. Suedmeyer WK, Bermudez AJ, Barr BC, Marsh AE: Acute pulmonary *Sarcocystis falcatula*-like infection in three Victoria Crowned Pigeons (*Goura victoria*) housed indoors. J Zoo Wildl Med 32:252-256, 2001
  4. Smith JH, Meier JL, Neill PJG, Box ED: Pathogenesis of *Sarcocystis falcatula* in the Budgerigar II. Pulmonary Pathology. Lab Invest 56:72-84, 1987
  5. Gardiner CH, Fayer R, Dubey JP: An Atlas of Protozoan Parasites in Animal Tissues, 2nd ed., p. 34. Armed Forces Institute of Pathology, Washington, D.C., 1998
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**CASE IV** – X4233 AVC Pathology (AFIP 2943289).

**Signalment:** Adult female moose (*Alces alces*).

**History:** On February 14, 2003, in western Newfoundland, Canada, this free-ranging, wild moose was seen dragging a hind leg through the snow and was not very alert. The investigating conservation officer euthanized the animal with a gunshot behind its ears and submitted its head to the provincial Animal Health Division for examination.

**Gross Pathology:** The entire brain is received for histological examination. A relatively well demarcated, expansile, oval mass (4.6 cm rostral-caudal dimension; 3.2 cm dorsal-ventral dimension; and 4.2 cm lateral dimension) is replacing much of the diencephalon, primarily centered on the thalamic region. The mass extends across the interthalamic adhesion to affect both sides of the brain. Bilaterally, the rostral and dorsal aspects of the mass are compressing the interventricular foramen; the rostral aspect of the mass is compressing the third ventricle; and the ventral aspect of the mass is obliterating the mesencephalic aqueduct, restricting and preventing the normal flow of cerebrospinal fluid. The result is a moderate increase in accumulation of cerebrospinal fluid, dilating the lateral ventricles (i.e., moderate hydrocephalus). There is also mild compression atrophy of the cerebrum overlying the lateral ventricles. Irregular areas of necrosis are present within the mass.

**Laboratory Results:** Immunohistochemistry:

1. Glial Fibrillary Acid Protein (Avidin biotin complex – peroxidase) – the cytoplasm of neoplastic cells stains strongly for Glial Fibrillary Acid Protein.
2. Vimentin (Avidin biotin complex – peroxidase) – the cytoplasm of neoplastic cells stains moderately for vimentin.

The immunohistochemistry results support the diagnosis that the neoplastic cells are of astrocyte origin.

**Histopathologic Description:** In this section of brainstem, a nonencapsulated, well delineated thalamic mass is compressing the adjacent surrounding neuropil. The mass consists of sheets of round cells supported by a delicate fibrovascular stroma. The cells have variably well defined cell borders; a small to moderate amount of finely granular, acidophilic cytoplasm that in some cells contains large discrete clear vacuoles; and a single round or oval or indented nucleus with three to five fold anisokaryosis, a finely granular chromatin pattern and multiple prominent nucleoli. A few binucleate and trinucleate cells are admixed with other cells. Mitotic figures are very common (at least one mitosis and often multiple mitoses are observed in a single random high power field). Several areas of necrosis are randomly distributed throughout the mass. Microhemorrhages and areas of locally extensive hemorrhage are also randomly scattered throughout the mass (this finding is likely related to the gunshot trauma associated with euthanasia). There is artefactual vacuolization of the adjacent unaffected neuropil due to post mortem autolysis.

**Contributor's Morphologic Diagnosis:** Astrocytoma, high-grade (glioblastoma multiforme) with secondary moderate hydrocephalus

**Contributor's Comment:** The tumor is diagnosed as an astrocytoma based on criteria previously described in the literature.<sup>1,2</sup> These include the anatomical location of the tumor (i.e., thalamic region), the morphology of the neoplastic cells, and the immunohistochemical detection of glial fibrillary acid protein (GFAP) and vimentin in the neoplastic cells' cytoplasm. Several classification schemes have been proposed for astrocytomas.<sup>1,2,3</sup> The astrocytoma in this case is considered high-grade because it is characterized by features of anaplasia such as increased cellularity, cellular pleomorphism, nuclear atypia, high mitotic index and necrosis. However, the additional features of vascular proliferation and pseudopalisading of neoplastic cells around necrotic areas described in some high-grade astrocytomas are absent in this tumor.

Astrocytomas are among the most common primary central nervous system tumors in aged dogs and cats, but they are rare in other domestic animal species.<sup>1,2,3</sup> These neoplasms have been reported in free-ranging Cervidae, including white-tailed deer (*Odocoileus virginianus*) and elk (*Cervus canadensis*).<sup>4,5,6</sup> However, the literature is sparse on cases of neoplasia in wild moose, and, to our knowledge, this is the first report of a primary brain tumor identified in this species.

**AFIP Diagnosis:** Brain: Astrocytoma, high-grade (glioblastoma multiforme), moose (*Alces alces*), artiodactyl.

**Conference Comment:** Glioblastoma multiforme or high-grade astrocytoma is the most malignant variant of astrocytoma characterized by anaplastic features, vascular proliferation and/or necrosis. In the dog, brachycephalic breeds are predisposed, in particular, the Boxer and Boston Terrier.<sup>2,7</sup>

Grossly, high-grade astrocytomas affect the convexities of the cerebral hemispheres, the temporal and piriform lobes, the thalamus-hypothalamus, the midbrain, and less commonly, the cerebellum and spinal cord. They are often well-demarcated, gray-white, with variable amounts of necrosis and hemorrhage. Edema of the surrounding neuropil is often present.<sup>1,2,7</sup>

Typical light microscopic findings include a hypercellular mass of small, round, fusiform to anaplastic cells with hyperchromatic nuclei, glomeruloid vascular proliferation, pseudopalisading of neoplastic cells around necrotic areas, scattered multinucleate cells, and mitoses. Areas of well-differentiated astrocytoma are often present within high-grade astrocytomas. A rare giant cell variant consists predominantly of bizarre giant cells and multinucleated cells. High-grade astrocytomas are variably immunoreactive for GFAP, vimentin, and cytokeratin.<sup>1,2</sup>

The differential diagnosis includes low-grade (well-differentiated) astrocytoma, medium-grade astrocytoma, gliomatosis cerebri, anaplastic oligodendroglioma, mixed gliomas (oligoastrocytoma), and primitive neuroectodermal tumor (PNET). The lower grade astrocytomas do not have necrosis. Gliomatosis cerebri is a diffuse glioma composed of elongate neoplastic cells that infiltrate diffusely but do not form a discrete mass. Because of postmortem autolysis and vacuolization, some conference participants also considered oligodendroglioma. Oligodendrogliomas are composed of neoplastic oligodendroglial cells with central, uniform, round nuclei and a halo of clear to lightly stained cytoplasm and have a background of branching capillaries forming a delicate "chicken-wire" pattern. Mixed gliomas (oligoastrocytomas) are a mixture of neoplastic astrocytes and oligodendrocytes and are not diffusely GFAP-positive. Primitive neuroectodermal tumors are composed of densely packed round to polygonal cells with often hyperchromatic carrot-shaped nuclei, rosettes, and pseudorosettes.<sup>1,2,3</sup>

Although glomeruloid vascular proliferation and palisading of neoplastic cells around areas of necrosis were not seen in this case, necrosis was present and is consistent with high-grade astrocytoma.

This case was reviewed in consultation with the AFIP Department of Neuropathology.

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**References:**

1. Koestner A, Higgins RJ: Tumors of the nervous system. In: Tumors in Domestic Animals, ed. Meuten DJ, 4th ed., pp. 699–703. Iowa State Press, Ames, Iowa, 2002
2. Summers BA, Cummings JF, de Lahunta A: Veterinary neuropathology, pp. 362-370. Mosby-Year Book, Inc., St. Louis, Missouri, 1995
3. Koestner A, Bilzer T, Fatzer R, Schulman FY, Summers BA, Van Winkle TJ: Histological classification of tumors of the nervous system of domestic animals, 2nd series, vol. V, pp. 17-21, 25. Armed Forces Institute of Pathology, Washington, D.C., 1999
4. Holscher MA, Page DL, Netsky MG, Powell HS: Mixed glioma and rhabdomyosarcoma in brain of a wild deer. Vet Pathol 14:643-647, 1977
5. Howard DR, Krehbiel JD, Fay LD, Stuht JN, Whitenack DL: Visual defects in white-tailed deer from Michigan: six case reports. J Wildl Dis 12:143-147, 1976
6. Snyder SP, Davies RB, Stevens D: Brain tumors in two free-ranging elk in Colorado. J Wildl Dis 17(1):101-104, 1981
7. Zachary JF: Nervous system. In: Pathologic Basis of Veterinary Disease, eds. McGavin MD, Zachary JF, 4th ed., p.949. Mosby Elsevier, St. Louis, Missouri, 2007

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