Western Conference for Veterinary Diagnostic Pathologists

Pathology of the Nervous System

Oct. 3rd & 4th 2014

Case Abstracts
Case 1 (D1406961)         Steven Scott

Cerebral Amyloid Angiopathy with Senile Plaques in an Amazon Parrot

Clinical History: A 30-40yr-old Amazon Parrot was found at the bottom of its cage with ruffled feathers. The owner reported that the bird was displaying abnormal behavior over the previous two weeks and elected for euthanasia.

Necropsy Findings: This 369-gm, female, Amazon parrot was in fair nutritional condition with small amounts of subcutaneous and coelomic fat stores. There was a focal, 1cm-diameter, area of hemorrhage in the right cerebral hemisphere. The lungs were mildly congested. The gastrointestinal tract was empty. No other external or internal abnormalities were noted.

Histopathology: Diffusely meningeal and cerebral vessel walls are expanded by amorphous, homogeneous or radiating fibrillar, eosinophilic material (amyloid). Similar amyloid plaques (senile plaques), measuring up to 75-um in diameter, and few polyglucosan bodies (Lafora bodies) are randomly distributed throughout the neuropil. Vessel walls are less commonly disrupted by hyalinized, beaded, eosinophilic material admixed with necrotic debris (fibrinoid vaculitis). The surrounding neuropil is frequently disrupted by multifocal to coalescing areas of hemorrhage and ischemic necrosis, characterized by vacuolation and fragmentation of the neuropil which contains neurons that are frequently shrunken, angular, hypereosinophilic, with pyknotic or karyorrhectic nuclei (necrosis). Glial cells are multifocally reactive and necrotic.

Morphological Diagnosis:
1. Cerebral hemorrhage and necrosis with cerebral amyloid angiopathy, fibrinoid vascular necrosis, and senile plaques

Ancillary Diagnostics:
- **Histochemical stains:**
  o *Congo red*: amyloid deposits are diffusely and strongly congophilic
- **Immunohistochemistry:**
  o *Amyloid precursor protein (β-amyloid)*: positive

Conclusion: Deposition of β-amyloid in the walls of cerebral vessels is consistent with a diagnosis of cerebral amyloid angiopathy (CAA). These findings, in addition to senile plaques (SP), have been described in several species, including canines, wolverine, non-human primates, humans, and single cases in an aged-California sea lion and a great spotted woodpecker. In humans, accumulation of cerebral β-amyloid is strongly implicated in the pathogenesis of Alzheimer’s disease, and similarly CAA and SP have been associated with age-related cognitive dysfunction in dogs. Neurofibrillary tangles (hyperphosphorylated tau protein), which are an additional feature of Alzheimer’s disease, were not appreciated in this parrot. Cerebral amyloid angiopathy has also been recognized as an important cause of cerebral hemorrhage in humans. The precise mechanism leading to accumulation of β-amyloid is uncertain.
In this parrot, amyloid was restricted to the brain and there was no evidence of inflammation in additional tissues; therefore, cerebral β-amyloid accumulation is likely an age-related change, as described in other species.

References:


Case 2 (D1403736)         Steven Scott

**Canine Adenovirus-1 (Infectious Canine Hepatitis Virus)**

**Clinical History:** This 5.3-kg, 8-week-old, intact female, collie-cross was found dead. There was no vaccination history and the puppy failed to thrive over the preceding two weeks.

**Necropsy Findings:** This puppy was in good nutritional condition with adequate subcutaneous and visceral fat stores. The oral cavity contained a small amount of frank blood. There was generalized pallor of the skeletal muscles and heart. The thorax contained approximately 10-mL of red-tinged serosanguinous fluid. The lungs were diffusely congested. Petechial and ecchymotic hemorrhages were noted in the subcutaneous tissues and intestinal serosa. There were no other external or internal abnormalities noted.

**Histopathology:** Within this section of cerebral cortex and thalamus, meningeal and parenchymal vessels are diffusely lined by hypertrophic (reactive) endothelial cells and rarely vessel walls are obscured by nuclear debris and amorphous eosinophilic proteinaceous material (vasculitis). Occasionally, endothelial cells contain a single, round, homogeneous, basophilic, intranuclear viral inclusion that peripheralizes the chromatin and is surrounded by a clear halo. Within the surrounding neuropil there are multifocal petechial hemorrhages and mildly increased numbers of reactive microglial cells and astrocytes, which occasionally form discrete nodules (glial nodules). There is moderate spongiform change throughout the section (postmortem autolysis).

**Morphological Diagnosis:**

**Cerebrum and thalamus:** vasculitis, multifocal, mild-moderate with gliosis, hemorrhage, and endothelial intranuclear viral inclusions

**Ancillary Diagnostics:**

- **Immunohistochemistry:**
  - Canine adenovirus-1: positive
  - Canine distemper virus: negative
  - Canine parvovirus: negative
  - *Toxoplasma gondii*: negative
Comments: Canine adenovirus-1 causes significant clinical disease in canids and members of the Ursidae family (bears). The most common presentation in dogs infected with CAV-1 is acute centrilobular to panlobular hepatic necrosis, often in association with hemorrhages and disseminated intravascular coagulation. Central nervous system manifestation of CAV-1 infection in dogs is rare, but when present consists of vasculitis, hemorrhage, and intranuclear inclusions within endothelial cells. Similar lesions have been described in foxes with so-called “fox encephalitis”.

Additional lesions in this dog included mild hepatic necrosis. Reactive endothelial cells containing viral inclusions were less commonly present in the liver, lung, and kidney.

References:


**Bacterial meningitis in a white-tailed buck**

**Clinical history:** A white-tailed buck was submitted on 11/26/13 to determine the cause of unusual behavior. The deer was euthanized after demonstrating lethargy, circling and loss of fear of humans.

**Necropsy:** The left antler was broken. A large quantity of purulent exudate was covering the right cerebral hemisphere and the meninges over the right cerebral hemisphere were cloudy in appearance.

**Histopathology:** Microscopic examination of the brain revealed chronic suppurative meningitis.

**Ancillary diagnostics:** Trueperella pyogenes was isolated from the brain and from a meningeal swab. Additional testing was negative for chronic wasting disease and epizootic hemorrhagic disease.

**Diagnosis:** Bacterial meningitis associated with Trueperella pyogenes.

**Comments:** Intracranial abscessation and meningitis is most commonly observed in male deer greater than one year of age. Cases are usually seasonal from September through April. Increased risks include velvet shedding, antler casting, antler rubbing and sparring.

Infectious thrombotic meningoencephalitis in a feedlot animal

Clinical history: Received formalin fixed sections of brain and heart from a feedlot animal for examination. The animal was 35 days on feed when it developed sudden onset of ataxia. The animal went down shortly thereafter. The animal was treated with Ceftiofur and Dexamethasone. The referring veterinarian noted fibrinous pericarditis at postmortem examination.

Gross Pathology: Gross examination of the formalin fixed tissues revealed multifocal, randomly scattered, 3-5 mm areas of hemorrhage within all sections of brain. The epicardium had a ground glass appearance and extensive hemorrhage was noted within the myocardium.

Histopathology:

Brain: In all sections examined, there is a multifocal to coalescing inflammatory lesion involving both the parenchyma and the meninges. The lesion frequently centers on blood vessels that are lined by plump endothelial cells and contain bacterial emboli (Gram negative coccobacilli). The tunica media is frequently disrupted by fibrinoid change and neutrophilic inflammation (vasculitis). Thrombosis is common. Large numbers of degenerate neutrophils disrupt the neuropil and are frequently accompanied by hemorrhage. The meninges are similarly expanded by edema, fibrin, hemorrhage and neutrophilic inflammation.

Morphological diagnosis: Meningoencephalitis, necrosuppurative and hemorrhagic, multifocal to coalescing, severe, acute with intraleional coccobacilli, necrotizing vasculitis, and thrombosis

Ancillary test: Immunohistochemistry for Histophilus somni was positive

Etiology: Histophilus somni

Comments: Histophilus somni (formerly Haemophilus somnus) is a Gram-negative, pleomorphic bacillus or coccobacillus, and a member of the family Pasteurellaceae. This bacterium acts as an obligate commensal and resides on the mucosal surfaces of the respiratory and genital tracts of healthy, male and female cattle. Histophilus somni can also act as an opportunistic pathogen and is associated with significant economic loss in large commercial feedlots in North America.

When infection with this organism was first described in 1956, the primary form of the disease noted was infectious thrombotic meningoencephalitis (formerly thromboembolic meningoencephalitis). However, H. somni is now associated with a large number of other disease manifestations including bronchopneumonia as a single etiologic agent or as a pathogen component of the bovine respiratory disease (BRD) complex, fibrinous pleuritis, necrotizing laryngitis, polyarthritis, fibrinous pericarditis, necrotizing myocarditis of the left papillary muscle, otitis media, and reproductive failure. Although initially recognized as a cause of neurologic disease in cattle, Histophilus somni is now recognized most frequently in feedlot cattle with BRD and myocarditis. The reason for this change in disease expression is unknown, but may be due to changes in treatment practices or the emergence of new strains.

References:

Lymphoplasmacytic encephalomyelitis due to protozoan organisms

Clinical history: Three month old male Great Pyrenees puppy with a 1 month history of progressive neurological deficiency (ascending paresis progressing to paralysis, hyperextension of the hind limbs, circling to the right) not responsive to treatment with NSAID and antibiotic.

Histopathology:

Brain: Affecting the grey and white matter, there is rarefaction of the neuropil, aggregates of glial cells (gliosis), malacia, fragmented nuclear and cellular debris (necrosis), infiltration by lymphocytes, macrophages, eosinophils, and occasionally, shrunken, pink neurons (necrosis). In the white matter, multifocal axons are swollen (spheroids). Meninges and Virchow-Robbins spaces around blood vessels are infiltrated by lymphocytes and plasma cells. There is multifocal hemorrhage.

Spinal Cord: In the grey matter, neurons are occasionally swollen and pale with peripheralized nuclei by thin Nissl substance (chromatolysis). In the grey and white matter, there are multifocal areas of malacia with increased glial cells (gliosis). Within the white matter, multifocal axons are swollen (spheroids). In longitudinal sections, there are linear arrangements of swollen myelin sheaths with central macrophages (digestion chambers; Wallerian degeneration).


Ancillary test: Immunohistochemistry supported diagnosis of protozoan cysts as Neospora caninum.

Etiology: Neospora caninum

Comments: Neospora caninum is an apicomplexan coccidian parasite with worldwide distribution. Dogs (the definitive host) may become infected through the ingestion of tissue cysts containing bradyzoites from intermediate hosts (cattle, sheep and goats). Bradyzoites from ingested cysts may form tachyzoites that become cysts in the dog's muscles, which may be responsible for transplacental infection of puppies. Infection is most severe in congenitally infected puppies with disseminated disease associated with progressive neuromuscular signs such as ascending limb paresis, tetraparesis, rigid hind limb extension, seizures and circling. On histology a nonsuppurative encephalomyelitis, polyradiculoneuritis, ganglionitis, myositis and myofibrosis are characteristic findings. Tissue cysts are present mainly in the central and peripheral neural tissues. Because lesions caused by Neospora caninum are similar to those caused by Toxoplasma gondii or to granulomatous meningoencephalitis, diagnosis must be confirmed with immunohistochemistry, as was done in this case.

I would like to thank Jamie Rothenburger at the Western College of Veterinary Medicine for this case.

References:

Taflan disease in piglets

**History:** This herd is experiencing sudden onset of neurological deficit in piglets. Within two to three weeks of entry into the nursery, piglets develop front limb ataxia that progresses to hind limbs, lateral recumbency and death.

**Necropsy Findings:** Lungs are edematous. There are no gross changes in the nervous system.

**Histopathology:** Spinal cord: there are multiple areas of hypercellularity in the grey matter most pronounced in the ventral horns. Multiple foci of gliosis with large number of neutrophils, rare eosinophils and plasma cells are centered on neurons. Glial cells and inflammatory cells often surround and invade hypereosinophilic granular nidus (degenerated neuron, satellitosis, neurophagia). Neurons show chromatolysis with pyknotic nucleus or are bright red (necrosis). Vessels in the grey and to a lesser degree in the white matter and meninges are cuffed by large number of macrophages with fewer lymphocytes, plasma cells and neutrophils. There is mild Wallerian degeneration in ventral tracts. Similar but milder changes are present in the thalamus and brain stem.

**Ancillary tests:** PCR positive for Porcine Teschovirus

**Diagnosis:** Poliomyelitis with neuronal necrosis, satellitosis and neurophagia

**Etiology:** Taflan disease

**Comments:** Taflan disease is a mild form of Teschen disease which has been first reported in Europe in 1929. This teschovirus (group 1 enterovirus) is found worldwide and sporadic outbreaks of paralysis in weaned and young grower piglets have occurred in Canada and USA. It is a neurotrophic virus with a predilection for the ventral horns of the spinal cord similar to poliomyelitis infection in people that causes paralysis. Taflan disease is on the list of Immediately Notifiable Diseases by Canada Food Inspection Agency but not by United States Department of Agriculture.

**References:**

http://www.thepigsite.com/diseaseinfo/121/teschen-disease

**Cryptococcus neoformans**

**History:** A 2-year old, black and white, intact male, German wirehair pointer had a two-week history of decreased appetite and activity level. The submitting veterinarian did a chemistry profile, complete blood count (CBC), and urinalysis. The urine specific gravity was 1.006 and a large number of neutrophils were found in the urine sediment. The dog was prescribed Simplecef. The next day, the dog developed ataxia and a head tilt. The chemistry and CBC were repeated, and the dog was tested for leptospirosis, heartworm disease, lyme disease, and anaplasmosis. All of these tests were within normal limits. The dog was prescribed Zeniquin. Two days later, the dog was referred to Emergency Services, where it was prescribed clindamycin and prednisone. After a one-day improvement, the dog deteriorated and was euthanized and submitted for necropsy.

**Necropsy Findings:** Other than slightly enlarged kidneys and prostate, there were no significant macroscopic lesions.

**Histopathology:** Brain: Diffusely the meninges were expanded up to 10 times by clear spaces (edema), moderate numbers of lymphocytes, plasma cells and macrophages admixed with numerous yeast organisms that were 5-15 um diameter, round to oval, extracellular yeasts with a 1 um thin wall and a 2-8 um thick, amphophilic, mucinous capsule, that exhibit narrow-based budding. The Virchow-Robins spaces were occasionally expanded with clear spaces (edema) and small numbers of lymphocytes, plasma cells, macrophages, and yeast organisms.

Spinal cord: lesions similar to the brain. Kidney: Moderate granulomatous pyelitis with numerous Cryptococcus organisms. Lungs: Mild to moderate granulomatous pneumonia with with numerous Cryptococcus organisms.

**Ancillary diagnostics:** Cryptococcus neoformans was isolated from the lung and brain.

**Diagnosis:** Marked granulomatous meningitis with numerous Cryptococcus organisms.

**Comments:** This dog had disseminated cryptococcosis. Cryptococcosis is disease that is thought to be acquired from the environment and is sporadically reported in humans and animals in North America [1, 2, 3]. Although the bacteriology lab reported the isolate as Cryptococcus neoformans, the molecular typing was not reported. There are 8 molecular types that include: VNI, VNII, VNIII and VNIIV for C. neoformans and VGI, VGII, VGIII and VGIV for C. gattii. Southwestern British Columbia is considered to be endemic for C. gattii [1,2] with VGIIa being isolated in a Saskatchewan dog that traveled to Vancouver island [2] and a recent study demonstrated that VGI, VGIIa, VGIIb, VGIIc, VGIII and VNI have been found up the west coast and scattered throughout the United States [3].

Follow-up information on the dog: it never left the Southern Minnesota – Northern Iowa area.

**References:**

Peripheral nerve sheath tumor

**History:** Surgical biopsy from a 9-year-old, female, spayed, Labrador retriever. The mass has been present on the right dorsal carpus for approximately 2 weeks (rapid growth). The fine needle aspirate of the mass yielded numerous spindle cells with nuclear variability. The mass was expansile, firm, white and multilobular and excised from the subcutis.

**Specimen:** One mass measuring 2.5x2.4x1 cm was submitted fixed in formalin.

**Histopathology:** The slide contains two sections of one excisional biopsy. The multilobular, unencapsulated and densely cellular mass is surrounded by a scant amount of subcutaneous connective tissue. The central portion of the mass is composed of palisading bundles of neoplastic spindloid cells with perivascular whorls and small psuedocystic formations, surrounded by interwoven bundles of neoplastic spindloid cells within a fibrovascular stroma. The neoplastic cells are spindloid with scant eosinophilic cytoplasm. The nuclei are pleomorphic ranging from round to elongate to indented with finely stippled chromatin and 1-2 small nucleoli. There is a moderate amount of anisokaryosis. Mitotic figures are extremely rare with less than 1 per 400X high power field. There are numerous lymphocytes admixed with plasma cells and a few macrophages surrounding several blood vessels.

**Diagnosis:** Subcutaneous mass, peripheral nerve sheath tumor (PNST).

**Comments:** PNSTs arise from Schwann cells, perineurial fibroblasts or both, and they contain various amounts of collagenous stroma. The benign schwannomas and neurofibromas are considered rare. The malignant schwannomas and neurofibrosarcomas are more common in dogs than cats. For IHC, S100 is a Schwann cell marker, claudin-1 is a perineurial cell marker, nestin is a neural crest stem cell marker, and NGFR has been used as a marker for Schwann cell differentiation [1,2].

**References:**

Brain Infarction

**History:** A 13.5-year-old, female, spayed Shih-Tzu presented with a 1-month history of anorexia, chronic weight loss, weakness and nasal discharge. The clinical diagnoses were chronic kidney disease, dental disease and grade III/VI heart murmur. The dog was euthanized and submitted for necropsy evaluation.

**Necropsy findings:** Nervous system: At the level of the thalamus and within the lateral cerebral cortical white matter, there were 3 1-2 mm diameter, dark red foci. There was a 1 mm, round dark red foci in the right rostrolateral cerebral cortex at the level of the genu of the corpus collosum.

The lenses of both eyes were diffusely opaque and white. The kidneys were diffusely firm and had multifocal 1-3 mm diameter cysts containing clear, yellow, watery fluid (urine) and a grainy texture. Diffusely along the free edge of the mitral valve leaflets and multifocally along the free edge of the tricuspid valve leaflets, there were numerous 1-3 mm diameter, round, smooth, white nodules. There was mild, generalized muscular atrophy. There was severe periodontal disease and dental calculus with only 5 teeth still present. The left-canine tooth was loose within a fistula from the oral cavity into the nasal cavity. The nasal cavity contained a small amount of creamy white material.

**Histopathology:** Focally in the right temporal lobe of the cerebral cortex at the level of the hippocampal formation, there was a poorly delineated, almost wedge shaped area containing a large amount of organized fibrin, fibroblasts, fibrous connective tissue and large clear spaces that also multifocally contained large pools of yellow homogenous material (hematoiden) and many brown pigment laden macrophages (hemosiderin). This area was peripherally surrounded by a large number of brown pigment laden macrophages (hemosiderin). In the surrounding neuropil, there were small areas of rarefaction with and without hemorrhage, large numbers of gemistocytic astrocytes dilated myelin sheaths and gliosis. Many of the surrounding blood vessels were shrunken and mineralized. There were also areas of cavitation in the interior portion of this lesion. There was also a small (1 mm diameter) foci of hemorrhage in the cerebral cortex in the gyrus adjacent to the caudate nucleus.

**Diagnosis:** Brain: infarction, focally extensive.

**Comments:** The infarction in the brain was an incidental finding and the underlying cause was not determined. The location of this infarct may not have inhibited normal function, and therefore, may not have had any associated clinical signs.

This dog had evidence of chronic renal failure with a greater than 70% loss of functional renal tissue resulting in mineralization in the lungs and kidneys. This dog also had a common age-related finding of valvular endocardiosis as well as glaucomatous and cataract changes in the eyes. The nasal discharge reported was due to the fistulation of the tooth root abscess on the canine tooth that resulted from severe, long standing periodontal disease.
Case 10 (CPSR 13-397-1-E)  
Mary Lauren Mesich

Glioblastoma multiforme in a Dog

Clinical history: An eight year old, male castrated, Springer Spaniel dog presented with a large mass in the frontal sinus causing deviation of the right eye; there were no neurological signs. The dog had a history of a partial frontal lobectomy for a brain tumor 1 year previously. MRI of the brain and nasal cavity showed a large mass within the nasal cavity and frontal sinus that was lytic, invading the cribiform plate and extending through the frontal bone into the right orbit. A second debulking surgery and biopsy of the frontal sinus mass was performed 3 months after this MRI and the dog was euthanized 9 days later due to dyspnea.

Necropsy: There was a multilobular, firm, tan mass involving the cribiform plate, partially filling the frontal sinus, obliterating the ethmoid and caudal nasal turbinates, and protruding through the right frontal bone and orbit causing deviation of the right eye. The brain was grossly normal except the rostroventral aspect of the right frontal lobe was absent (previously surgically removed).

Histopathology: Nasal cavity – Within and invading the nasal turbinates is a densely cellular, poorly demarcated, and multilobular neoplastic mass. The lobules of the neoplastic tissue are surrounded by dense bands of fibrovascular tissue. Multifocally the lobules also contain large irregular to serpentine areas of necrosis with peripheral pseudopalisading cells. The constituent neoplastic cells are highly pleomorphic and arranged in multiple patterns; there are haphazard sheets, cords, or packets of polygonal cells and elongate cells arranged in intersecting streams. Neoplastic cells often form palisades around small to medium caliber vessels (perivascular pseudorosettes). The neoplastic cells have a moderate to large degree of anisocytosis and anisokaryosis with 46 mitoses in 10 high powered fields (40x objective). Additional findings include: multifocal areas of resorption of bone, ulcerated nasal mucosa, submucosal aggregates of lymphocytes, plasma cells, and siderophages.

Morphologic diagnosis: Glioblastoma multiforme (WHO Grade IV/IV astrocytoma)

Ancillary Tests: Immunohistochemistry – Glial Fibrillary Acidic Protein (GFAP) – There is diffuse, intracytoplasmic, and sometimes intensely positive immunoreactivity in the neoplastic cells.

Comments: This is a highly unusual case of glioblastoma multiforme (GBM) due to extensive invasion of the tumor in the nasal cavity with a clinical presentation related to respiratory difficulty and the mechanical effects of the tumor without neurologic signs and minimal microscopic neurologic involvement. Additionally the histologic morphology of this GBM was markedly more heterogeneous than normal. GBM is a rare form of astrocytoma in dogs representing only 5% of the approximately 10% incidence rate of astrocytomas among primary CNS tumors. This is in stark contrast to humans where GBM is the most common CNS tumor. Although this tumor is classified as a grade IV astrocytoma by the World Health Organization (WHO), the historical name, GBM, endures and is more commonly used. Many features are similar between an anaplastic astrocytoma (WHO grade III astrocytoma) and a GBM however differentiation is determined by the presence of characteristic serpentine necrosis with pseudopalisading glial cells as well as frequent neuronal satellitosis and perivascular tumor infiltrates. The necrosis in GBM is not only a key morphologic feature and predictor of poor prognosis in humans but also likely contributes to its highly malignant nature. This state involves production of growth and angiogenic factors and necrosis-induced hypoxia which stimulates up-regulation of migration-associated genes and possibly selecting for more malignant tumor cells. Canine GBMs have been noted to express epidermal growth factor receptor and vascular endothelial growth factor in 60% and 40% of the tumors, respectively. A subpopulation (termed ‘cancer stem cells’) of a dog GBM has been identified that can proliferate, self-renew, and differentiate and has been shown to be able to produce a similar brain tumor in an inoculated mouse model. In this case, the previous transfrontal surgical approach may have allowed tumor access to the frontal sinus and sequentially the nasal cavity.

References:
Hypernatremic Polioencephalomalacia in Pigs

**History:** Three Yorkshire-cross gilts out a group of 23 pigs at a small hog farm in Eastern Washington went off feed and drink after a change in supplementation during a week of exceptionally cold weather in December. The day prior to death the gilts were circling and bumping heads against the wall. There were no other recent changes in feed or management.

**Necropsy Findings:** Gross lesions in one gilt included locally extensive and severe subdural hemorrhage in the atlanto-occipital region, contusion on the left hind limb, and marked small intestinal ascariasis.

**Histopathology:** Within the dorsolateral cortical cerebrum at the interface between the grey and white matter there is a thick linear band with marked rarefaction of the neuropil and widely scattered to locally extensive neuronal necrosis characterized by hypereosinophilic angular neurons with pyknotic nuclei. Within these regions, variable numbers of eosinophils infiltrate the Virchow Robin’s space, and the adjacent neuropil is mildly edematous. Affected blood vessels are lined by hypertrophic endothelial cells. The meninges are similarly and mildly to moderately affected.

**Ancillary Test Results:** The brain sodium level was 1700 µg/g. Sodium concentrations of brain tissue can vary depending on the hydration status of an animal, and therefore often do not correlate well with clinical or histopathologic evidence of a salt intoxication diagnosis. Sodium concentrations of brain tissue > 1500 ppm or µg/g wet weight have been associated with known cases of salt intoxication in swine.

**Morphological Diagnosis:** Laminar cortical necrosis with eosinophilic vascular cuffing

**Etiology:** Sodium toxicity/water deprivation

**Comments:** The clinical history and histological changes are pathognomonic for hypernatremic polioencephalomalacia. The critical level of salt in the fodder is approximately 2% when water intake is restricted. Alternatively, indirect sodium toxicosis can occur with water deprivation alone. In either scenario, signs of poisoning occur when the water supply is replenished after a period of water restriction. Differentials for laminar cortical necrosis include lead poisoning, salt toxicity, sulfur toxicity, hypoxia, and thiamine deficiency. Perivascular eosinophilic infiltrates are a finding specifically associated with sodium toxicosis in pigs.

**References:**
Case 12 (2013-12500)        Melissa Macias

Mucopolysaccharidosis type IIIB in emus

Clinical history: Two 6 month old emus with a history of disorientation and ataxia were found dead.

Gross findings: **Emu A:** There are 125.0 ml of free blood and a large blood clot within the coelom. The clot is completely covering the right hepatic lobe and is firmly adhered to 25% of the right hepatic lobe. The right lobe is firm, enlarged and dark red. The remaining liver is diffusely pale orange. Beneath the capsule of the left hepatic lobe is a 4.0 x 3.0 x 1.5 cm well demarcated firm and dark red to brown mass (clot). **Emu B:** The liver is pale red, diffusely friable and soft. The renal cortex is partially covered by pale tan to white, gritty material (urate). On cross section, homogenous, yellow fluid drains from the renal pelvis.

Histopathology: Similar microscopic changes are observed in both animals.

Nervous system: Within the spinal cord and numerous nuclei of the brainstem, pyramidal neurons are swollen and contain many small, intracytoplasmic vacuoles that compress the Nissl substance to the cellular margins. There are rare spheroids and eosinophilic axons, with rare digestion chambers.

Liver: Hepatocytes are diffusely swollen by numerous, small, clear, intracytoplasmic vacuoles. Rarely, among the hepatocytes are several variably sized aggregates of macrophages that have abundant intracytoplasmic vacuoles similar to those in the hepatocytes.

Morphological diagnoses:
- Neuronal vacuolation, diffuse, chronic, severe, brain, spinal cord, and small intestinal ganglia, with axonal degeneration
- Hepatic vacuolation, diffuse, chronic, severe

Ancillary test: Slightly PAS-positive intracytoplasmic granular material in neurons

Etiology: Absence of a lysosomal enzyme (condition: Mucopolysaccharidosis type IIIB)

Comments: Lysosomal storage diseases (LSDs) are a group of metabolic disturbances resulting from deficiencies in specific lysosomal acid hydrolases. These diseases are usually chronic and progressive with a wide spectrum of clinical severity depending on whether the central nervous system (CNS), musculoskeletal system, and other organ systems are affected. Mucopolysaccharidosis type III results from the absence of 1 of 4 lysosomal enzymes involved in the degradation of heparan sulfate. Clinical history includes weakness, anorexia, lethargy, ataxia, circling, pecking at the air, drooping head, limping, curled toes, walking backward, torticollis, crooked legs, and unexpected death. Gross lesions are highly variable, but mainly involve different sites of hemorrhage, including hepatic rupture, with hemocoelum and hemorrhage in the liver, sternum, neck, thigh, and right atrioventricular valve. Fatty liver also has been reported. Evidence of storage disease can be found in the CNS, liver, heart, aorta, intestine, spleen, and eye. Liver lesions include moderate to severe, multifocal infiltration of large foamy macrophages containing high numbers of fine clear cytoplasmic vacuoles, diffuse lipidosis, and mild chronic lymphoplasmacytic and histiocytic hepatitis are typical. The age of the birds, the progressive neurological signs, and the light microscopic features are consistent with a diagnosis of lysosomal storage disease. A genetic test is available to detect carriers and affected animals.

References:
Case 13 (2013-10175)        Bethany Balmer

Canine distemper virus encephalitis in a 15-week-old puppy

History: A 15-week-old, female, Weimaraner puppy presented acutely with lethargy, purulent nasal discharge, conjunctivitis, an enlarged pre-scapular lymph node, and a mild fever (102.8). The clinical signs progressed over 30 hours to muscle tremors and blindness. The puppy began having grand-mal seizures, and was subsequently euthanized. This puppy was vaccinated with DHLPP 11 days prior to onset of clinical signs.

Necropsy Findings: The brain was grossly normal. The lungs were moderately edematous.

Histopathology: Brain: In multiple sections of cerebrum and midbrain, approximately 40% of the gray matter had numerous, individualized neurons that were shrunken, hypereosinophilic, angular, had pyknotic or absent nuclei and loss of Nissl substance (neuronal necrosis). Necrotic neurons were often surrounded by small aggregates of foamy macrophages (neuronophagia by gitter cells) with fewer lymphocytes and plasma cells. The gray matter neuropil was fragmented and had numerous clear spaces (rarefaction) and moderate numbers of gitter cells, lymphocytes, plasma cells and necrotic cells. Numerous small blood vessels in the affected areas were surrounded by small accumulations of lymphocytes and plasma cells (perivascular cuffing) and few necrotic cells.

Ancillary diagnostics: Immunohistochemistry (IHC) and direct fluorescent antibody (FA) were positive for canine distemper virus (brain). Virus isolation and FA on lung and tissue pool were negative for CDV.

Morphologic diagnosis: Polioencephalomalacia and encephalitis, lymphocytic, plasmacytic, and histiocytic, multifocal, acute, severe, with perivascular cuffing and neuronal necrosis; midbrain and cerebral gray matter

Comments: The histologic changes in the brain were primarily confined to the gray matter and no viral inclusions were observed. Canine distemper virus is an agent that generally affects the white matter of the brain, causes interstitial pneumonia and often has identifiable inclusions (intranuclear in the central nervous system, and intranuclear and intracytoplasmic in other tissues in the body). However, a post-vaccinal canine distemper encephalitis has been reported in puppies1 and other animals (ferrets2 and mink3). The lesions are not well documented, although they are reportedly restricted to the central nervous system with relative sparing of the white matter4. There was no histologic evidence of pneumonia. The pulmonary edema could be related to the seizure activity as well as acute cardiovascular collapse at the time of euthanasia. Rabies testing by the state of Washington was negative. Consultation with Dr. Sanjay Kapil at Oklahoma State University’s Diagnostic Laboratory yielded inconclusive results for vaccine-association based on the multifocal distribution of the brain lesions (vaccine-induced encephalitis is generally focal in his experience). His interpretation is that the strain could be an emerging antigenic variant of CDV with pathologic changes only in the CNS.

References:
**Equine Degenerative Myelopathy**

Contributor and presenter: Laura Williams, DVM  
Washington State University, Department of Veterinary Microbiology and Pathology, Washington Animal Disease Diagnostic Laboratory

**History:** An eight year old Arab mare presented to the referring veterinarian with a one week history of symmetrical ataxia, dysphagia, cranial nerve abnormalities, and conscious proprioception deficits. No abnormalities were noted on spinal radiographs or cerebral spinal fluid analysis. Humane euthanasia was elected.

**Necropsy findings:** Gross necropsy findings were largely unremarkable, besides moderate gastric ulceration. No gross abnormalities were detected in the skull, brain, vertebral column, or spinal cord.

**Histopathology:** Multifocally scattered throughout the white matter of the spinal cord are many dilated axon sheaths that occasionally contain swollen, hypereosinophilic axons (spheroids), or rarely contain Gitter cells with a small amount of cellular debris (digestion chambers). Occasional spheroids are scattered in the grey matter. Many neurons contain intracytoplasmic aggregates of globular, yellow-brown pigment (lipofuscin). In the brainstem, and most prominently in the cuneate nucleus, neurons are multifocally either swollen or shrunken, hypereosinophilic, and lack nuclei (neuronal necrosis).

**Morphological Diagnosis:**  
Axonal degeneration, multifocal, subacute, moderate, with spheroids; spinal cord  
Neuronal necrosis, multifocal, subacute, moderate; brainstem

**Etiology:** Equine degenerative myelopathy

**Comments:** Histologic changes in the central nervous system are consistent with equine degenerative myelopathy (EDM), a sporadic neuroaxonal dystrophic disease of young horses characterized clinically by proprioceptive deficits, symmetric ataxia, and limb weakness or dysmetria. No gross abnormalities are typically found on necropsy. Classically, the axons of the white matter of the caudal brainstem and spinal cord undergo multifocal to diffuse Wallerian-like degeneration. The pathogenesis is still largely unknown, but the disease is most likely caused by interactions of many factors. Hereditary predisposition, toxic insults, and nutritional deficiencies have been considered as risk factors. Complex interactions of oxidative stress in association with systemic vitamin E deficiency are widely accepted mechanisms of disease development, based on correlative studies in horses and comparative studies of neurodegenerative myelopathies in other species. EDM is chronically progressive, even with vitamin E supplementation, and euthanasia is usually necessary, as in this case.

**References:**
Case 15 (2014-2352)  Lindsay M. Fry

**Hydrancephaly due to in utero bluetongue virus infection in an Angus calf**

**History:** A 2.5 week old red Angus heifer calf was presented to the WSU Veterinary teaching hospital for evaluation of intermittent weakness and collapse, especially during nursing. On physical examination, the calf was ataxic and head pressing. An MRI revealed severe hydrancephaly, and the calf was euthanized and submitted to the Washington Animal Disease Diagnostic Laboratory for necropsy and histopathology.

**Necropsy findings:** The calvarium contains a moderate amount of clear, serosanguinous fluid. Bilaterally, the cerebral hemispheres are collapsed. The cerebral cortices are diffusely, severely thinned to 2-3 mm and are multifocally, completely absent beneath a thin dural membrane. Bilaterally, the lateral ventricles are severely dilated and filled with clear fluid. The cerebellum, brain stem and hippocampus are within normal limits.

**Histopathology:** Diffusely, the cerebral cortex is very thin, and is composed of compressed, disorganized neuropil with many randomly placed neurons. The white matter is disrupted by clear space (rarefaction).

**Ancillary Diagnostics:** PCR testing for epizootic hemorrhagic disease and bluetongue virus was performed on sections of brain from this calf. Bluetongue virus DNA was detected via PCR.

**Morphological Diagnosis:**

1. Hydrancephaly, brain, severe

**Comments:** Bluetongue virus is in the Orbivirus genus, and is primarily transmitted by Culicoides sp. midges. Infection has been documented on all continents except Antarctica, and the virus causes disease in ruminants, camels and some carnivores. Clinical signs and disease severity vary based on the viral strains involved and the species of animal infected; however, hallmark histologic lesions include vasculitis, pulmonary edema, and hemorrhage. Although considered rare in most strains, bluetongue virus can be transmitted transplacentally. The effect of in utero viral infection on the fetus is dependent upon gestational age at infection, where fetuses infected during early to mid-gestation usually develop brain lesions and those infected in mid to late gestation do not. The variation in fetal disease severity over time is caused by the strong tropism of the virus for undifferentiated supepidermal neuronal and glial precursor cells compared to mature brain cells. Infection of precursor cells leads to massive necrosis and resultant cortical attenuation and hydrancephaly. Prognosis for these animals is poor, and fetal infection can cause significant production losses.
References:


Equine intracarotid injection vasculitis and encephalomalacia

History: A 4-year-old Standardbred mare was treated with pre-race medication (arnica) which was accidently administered into the carotid artery. The horse collapsed into right lateral recumbency, and remained unresponsive. Cranial nerve function: no response to nasal stimulation, no menace response, weak to absent palpebral reflex, no nystagmus, no pupillary light reflex, flaccid tongue, no jaw tone. The mare died prior to initiation of treatment.

Necropsy: Upon skinning the neck, there was extensive hemorrhage and edema of cervical soft tissues and muscle surrounding the left jugular vein and carotid artery. The left carotid artery was surrounded by a zone of hemorrhage and adherent edematous muscle, extending for a length of approximately 25 cm. Upon sectioning, the cranial portion of affected pericarotid muscle was discoloured dull red-brown, and had a faint medicinal odour. A possible puncture was identified on the intimal aspect of the mid-carotid region. Meninges were moderately congested.

Histopathology: Cerebellum contains several folia typified by severe spongiosis of white matter. Rare transmigrating neutrophils are situated within expanded Virchow-Robin’s spaces. Overlying meninges are congested and edematous with markedly dilated lymphatic vessels. A few suspicious axonal spheroids are present. The hippocampus (24) contains a markedly spongiotic focus adjacent to pyriform nuclei. Several capillaries in this region are lined by swollen or hyalinized endothelium, and occasionally contain nuclear dust or erythrocyte fragments. Transmigrating neutrophils are also evident. A small malacic focus adjacent to pyriform nuclei consists of pyknotic microglia, rarefied neuropil and isolated faded neurons.

Morphologic Diagnosis: Marked locally extensive cerebral edema, focal malacia and vasculitis

Etiology: Accidental intracarotid injection

Comments: This horse’s neurologic signs and death were due to locally extensive cerebral edema and focal malacia caused by vascular injury following accidental intracarotid injection of a pre-race homeopathic compound containing Arnica montana. This plant of the Asteraceae family has been utilized as an alternative anti-inflammatory therapy, specifically for the treatment of exercise-induced pulmonary hemorrhage in horses. Literature describing the pathogenesis of intracarotid injection reactions is sparse. Lesions are asymmetrically distributed on the side of the injected carotid artery. Cerebral vessels exposed directly to high concentrations of injected chemicals undergo endothelial swelling, increased vascular permeability and mural necrosis, culminating in cerebral edema,
hemorrhage, thrombosis and malacia. All of these lesions, except for overt thrombosis, were noted in this case.

References:


Case 17 (11-053764-5)                          Maria Spinato

**Ovine focal symmetrical encephalomalacia**

**History:** The owner of a flock of 2000 mixed-breed meat sheep reported 4 sick and 2 dead 8-week-old lambs from a total of 300 lambs at risk. The referring veterinarian euthanized one lamb exhibiting flaccid paralysis, and performed an on-farm postmortem.

**Necropsy:** The lamb was emaciated. Mesenteric lymph nodes were edematous and tapeworms were present in the intestines. Fresh and fixed tissue samples were collected and submitted to the AHL for testing.

**Histopathology:** The cerebellum (5) contains two large, relatively well-demarcated foci of malacia and axonal degeneration: one within the cerebellar peduncle, and the second, smaller focus adjacent to the cerebellar lingula. Affected foci contain swollen axons, multiple digestion chambers, and scattered mononuclear/glial cells. The smaller focus appears partially collapsed and contains aggregated vacuolated macrophages and prominent mesenchymal cells. Cerebellar folia and Purkinje cells are unremarkable. Occasional mononuclear cells are infiltrating meninges (4). Cortical sections are mildly congested.

**Ancillary diagnostics:** None (no fresh or formalin-fixed intestine submitted)

**Morphologic Diagnosis:** Focal cerebellar encephalomalacia

**Etiology:** *Clostridium perfringens* type D epsilon toxin (suspected)

**Comments:** The microscopic lesion of focal cerebral malacia in a young lamb is highly suggestive of a condition called “focal symmetrical encephalomalacia” or FSE, believed to be caused by *Clostridium perfringens* type D enterotoxin in lambs that survive the acute stage of enterotoxemia. Gross lesions are often absent in sheep dying of type D enterotoxemia. Rarely, gross lesions are noted in the brain and may consist of cerebellar coning or hemorrhagic foci within the corpus striatum, thalamus, midbrain or cerebellar white matter tracts. Lesions in other tissues are infrequently present depending upon the stage of infection, and are similar to other clostridial enteritides; namely, small intestinal hyperemia, fluid red intestinal contents, hydropericardium +/- fibrin strands, pulmonary edema, glucosuria. Although kidneys may autolysed more rapidly in animals dying of enterotoxemia (hence the term “pulpy kidney disease), this is considered to be a non-specific postmortem change rather than a pathognomonic lesion.

When susceptible lambs are introduced to lush pasture or are switched abruptly to a high grain ration in feedlots, excessive starch enters the small intestine and causes resident *C. perfringens* type D bacteria to proliferate rapidly and produce abundant epsilon toxin. This toxin is absorbed, circulates systemically, and targets microvascular endothelium, binding preferentially to capillary endothelial cells in the brain. Damage to the blood-brain barrier results in increased vascular permeability, vasogenic cerebral edema and increased intracranial pressure. Lambs afflicted by this acute clinical stage may exhibit no clinical signs, or may show severe neurologic signs prior to rapid death. FSE occurs in subacute intoxication, suspected to be due to a lower toxin dose or partial immunity. The reason for selective damage to microvasculature in the basal ganglia, internal capsule, thalamus, midbrain and cerebellar peduncles is unknown. Endothelial damage causes vascular obstruction, ischemic-hypoxic neuronal injury and subsequent focal, bilaterally symmetrical necrosis.

**References:**
Animal signalment
Species: Canine
Breed: Yorkshire terrier
Age: 1y9m
Sex: FS

Clinical history:
Three-month history of progressing circling to the right. Absent CPS on left, central blindness, lethargic, and decreased appetite. MRI: multifocal hyperintensities in right cerebrum and brainstem. Clinical diagnosis: inflammatory brain disease. CBC WNL. Chemistry: mildly elevated ALT 134. AUS: liver hyperechoic, normal size, no shunt vessel, bilateral renal medullary mineralization or fibrosis. CSF: 57000 RBCs (likely contamination), 200 cells, protein 181.

Gross necropsy findings:
A 1.9kg 21 month-old female-spayed Yorkshire terrier in good body condition and good postmortem state is necropsied at 1pm on 2/5/13. There is evidence of a mild splenomegaly, most consistent with euthanasia [injection of barbiturates]. A CSF cytology showed many mononuclear cells, consistent with a non-suppurative inflammation of the meninges. The brain was trimmed in serial sections after one week fixation with buffered formalin 10%. Multifocal areas of softening were observed bilaterally and asymmetrically but mostly evident in the corona radiata, midbrain and pons [see gross picture]. No other lesions were observed on gross examination.
Necrotizing encephalitis of the Yorkshire terrier is a chronic non-suppurative meningoencephalitis that is described worldwide since its first description in Switzerland (Tipold et al., 1993). The disease is sporadic, equally affecting male and female, and mainly occurring in young adult dogs. Histologic lesions consist of multifocal variably extensive areas of cavitation necrosis, in particular in the cerebral cortex white matter and/or in the brain stem with additional prominent lymphoplasmacytic perivascular cuffs and severe reactive astrogliosis (Tipold et al., 1993). Immunohistochemical analysis identified the major infiltration of T lymphocytes and macrophages with implication of some cytotoxic lymphocytes and IgG-producing plasma cells T-cell-mediated and a delayed-type immune reaction as part of the pathogenesis (Lezmi et al., 2007).


Case of squamous cell carcinoma in the optic nerve of the cat

Clinical history: The female spayed 16 years old domestic long hair cat had a 3 month history of conjunctivitis which was treated bilaterally. The cat was presented to emergency service with sudden onset of ataxia and falling to the right. Upon examination, the cat was found to have right sided facial paralysis, ocular swelling, miotic pupils, equivocal right head tilt and heart murmur. The cat had a seizure and went into cardiopulmonary arrest.

Histopathology:

Right eye: Replacing part of the optic nerve and extending into the vessels of the choroid, surrounding ocular muscles and blood vessels, there is poorly demarcated, highly infiltrative, unencapsulated neoplastic mass. The neoplastic cells form nests and islands within optic nerve and surrounding tissues. The neoplastic cells are polygonal in shape with distinct cell borders and abundant eosinophilic finely granular cytoplasm. The nuclei are round with irregular indentations, vesicular to clumped chromatin and one prominent eosinophilic nucleolus. Mitotic figures are 0-1 per 10 HPF. Multifocally, some of the nests of neoplastic cells contain a small amount of keratin (squamous differentiation), and occasionally apoptotic cells are scattered throughout the mass. There are large clusters of lymphocytes admixed with few macrophages and plasma cells. Additionally, mild hemorrhage is present within ganglion and nerve fiber layer of retina.

Morphological diagnosis: Right eye (optic nerve): Squamous cell carcinoma

Ancillary test: Bacteriology, Toxicology – Negative.

Comments: Ocular tumors are uncommon in cats. A study of about 300 eye tumors in domestic animals found only eight intraocular tumors in cats. Squamous cell carcinomas, which are more common in white cats with nonpigmented eyelid margins, most often involve the eyelids, conjunctivae, and the nictitating membrane. In this particular case, squamous cell carcinoma within and around the optic nerve that extended to choroid was not considered to be a primary site of this tumor, but rather secondary. However, no primary tumor mass was identified at necropsy. Metastatic squamous cell carcinomas to eye, particularly to retrobulbar tissues surrounding the optic nerve are rarely reported in the literature. According to a literature the presence of the neoplastic cells at this location is mostly suggestive of intravascular dissemination and less likely contiguous invasion of tumor. The squamous cell carcinoma can also arise in the external auditory meatus or in the middle ear and progressively destroyed the surrounding soft tissues and bone. Other potential sites of origin can include the pinna, oral cavity, tongue, nasopharynx, and tonsils.

I would like to thank Dr. Susan E. Detmer as a contributor for this case.

References:

Hypertensive encephalopathy in a cat

Case Introduction: Adult cat, DLH, 8 years old, spayed female presented with acute onset of blindness Monday morning after being inappetent and acting oddly on Sunday; owner had noted polydipsia and polyuria over the preceding 2 weeks. Physical exam: severe hypertension (230 mm Hg Doppler). Basic bloodwork: NAF. Started having seizures, treated with mannitol. That evening went into respiratory distress, became anisocoric and mentally dull. Decision to euthanize was made. Gross necropsy findings were very nonspecific, largely confined to hyperemia/congestion.

Histopathology: BRAIN: There is a large poorly demarcated wide area of pallor within each dorsal parietal lobe extending from deep white matter and encompassing full thickness of the associated overlying grey matter. Pallor is caused by marked separation and accentuation of the linear myelin sheaths in white matter and marked vacuolation (spongiform change) in the overlying grey matter. Severe neuronal degeneration, necrosis and loss is seen with shrunken, eosinophilic and angular neurons, scattered nuclear debris (karyorrhexis) and heavy complement of glial cells, gitter cells and reactive astrocytes. Occasionally, glial cells replace neurons. There are a few microhemorrhages within the area of edema and necrosis in the grey matter. Vessels within the area of pallor show severe effacement of architecture by amorphous eosinophilic material and small amount of nuclear debris (fibrinoid change). These vessels are surrounded by large clear vacuoles (perivascular edema). Blood vessels with intact walls are often lined by hypertrophic (reactive) endothelial cells and surrounded by low numbers of neutrophils, macrophages, lymphocytes and plasma cells. Multifocally throughout the section, Virchow-Robin space is markedly expanded by clear space transected by fine eosinophilic strands (edema). Leptomeninges overlying the affected gyrus are mildly expanded by edema and low numbers of mixed inflammatory cells, mostly mononuclear with occasional neutrophils. Pial arteriolar walls often contain amorphous eosinophilic as droplets or circumferentially (protein leakage).

Morphologic Diagnosis: Brain, cerebrum, parietal lobes, bilateral, edema with neuronal degeneration, necrosis and loss, locally extensive, acute, severe associated with arteriolar fibrinoid change, acute, severe

Comments: Systemic hypertension as a clinically important condition in domestic cats was initially described in 1986. It has been defined as a sustained increase in systolic blood pressure ≥ 160-170 mmHg. Three clinical categories are recognized:
- Stress-induced (“white coat”) hypertension: transitory artifactual increase (median rise of 17.6 ± 5.9 mmHg) secondary to activation of the sympathetic nervous system in the classical “fight or flight” response;
Secondary hypertension: most common and associated with systemic diseases or treatments including chronic renal disease, hyperthyroidism, primary hyperaldosteronism, pheochromocytoma, diabetes mellitus and erythropoietin treatment; and

Idiopathic (primary or essential) hypertension: about 20% of hypertension in cats occurs in the absence of other demonstrable disease conditions.

Target organ damage (TOD) is a risk in the face of uncontrolled hypertension with the heart, brain, eyes and kidneys being most vulnerable. The risk of TOD is severe at >180mmHg\(^4,5\). This cat had a recorded pressure of 230mmHg at presentation. TOD was confirmed histologically with changes in the brain as described above. There were also changes in the eyes and kidneys, focused largely on vascular structures, specifically arterioles, with similar effacement by amorphous eosinophilic material with small amounts of nuclear debris, commonly known as fibrinoid change or necrosis.

This cat presented with acute onset of blindness and an anxious demeanor with rapid deterioration to seizuring and stupor. This is a classical presentation for TOD in a hypertensive cat with the first sign often being acute blindness due to catastrophic effusive retinal detachment. Sudden onset of intracranial neurological signs is also common. Renal and cardiac changes are generally more insidious. Accelerated progression of chronic kidney disease and development of congestive heart failure associated with left ventricular hypertrophy, respectively, are reported\(^3\). Pathogenesis of the insidious conditions is poorly understood, particularly regarding cause and effect\(^1\).

Hypertension in this cat was considered idiopathic despite being younger than reported age of >12 years for development of idiopathic hypertension\(^5\). Complete histological evaluation did not show pathology consistent with any of the conditions associated with secondary hypertension.

References:
Progressive Ataxia of Charolais Cattle

**History:** Female adult beef cow of unknown breed that has been intermittently recumbent for several days.

**Necropsy Findings:** Cow was in good condition and was 7-8 months pregnant. There were no significant gross lesions in the brain, and no fluorescence under UV light.

**Histopathology:** In the cerebellar white matter, there are multiple individual to coalescing, circular to ovoid, pale pink finely granular foci that are well delimited from the bright pink myelination surrounding white matter. Rare axons are present in these areas. Glial cells are often large, with ample eosinophilic cytoplasm, a large nucleus with clumped chromatin and prominent nucleolus. Some glial cells are bi-tri nucleated.

**Ancillary tests:** Luxol fast blue cresyl violet stain and Holmes stain confirm the lack of myelin and presence of axons in the foci.

**Diagnosis:** Leukodystrophy multifocal, chronic, severe

**Comments:** This presumed inherited disorder was first reported in 1972 in pure or mixed Charolais breed and is related to dysfunction of oligodendrocytes. The multiple areas of myelin loss in the white matter of the central nervous system are pathognomonic for this condition. It is a result of segmental defect of the myelin sheath at the node of Ranvier and paranodal region. The overall composition of the myelin is normal but there is failure of oligodendrocyte processes to ensheath a group of neighboring axons at their nodal region. This disorder has been termed an oligodendrocyte dysplasia leading to leukodystrophy. The onset of progressive hind end ataxia is between 6 to 36 months which eventually lead to complete recumbency. We have seen a few sporadic cases in Saskatchewan and the last recorded case in the PDS database is in 2001.

**References:**


**Canine distemper virus, suspect vaccine-induced**

**History and necropsy findings:** This 11-month-old Poodle cross dog developed muscle twitching, tremors, seizures and ataxia 4 days after vaccination against canine distemper. These clinical signs progressed over two weeks and the dog became disinterested and aggressive. There were no significant gross findings.

**Histopathology:** Section of cerebellum and pons. The changes are centered on grey matter, more specifically on neurons. Large numbers of neurons are hypereosinophilic (necrotic) with a large nucleus with clumped, margined chromatin and single large bright pink intranuclear inclusion body and rare, small, faint intracytoplasmic inclusion bodies. There is mild perivascular cuffing by plasma cells and macrophages, and scattered nodules of glial cells and plasma cells, often circling a shrunken necrotic neuron (satellitosis). Astrocytes in grey and white matter are often swollen with hypochromatic nucleus and pale pink intranuclear inclusion bodies. Myelin sheath in white matter tracts are multifocally distended, with loss of axons and presence of rare phagocytic mononuclear cells (Wallerian degeneration). Similar changes, restricted to grey matter, are present in the spinal cord.

**Ancillary tests:** Immunohistochemistry for Canine Distemper virus on spinal cord is positive

**Diagnosis:** Encephalitis with neuronal necrosis, satellitosis, Wallerian degeneration and presence of intranuclear inclusion bodies in neurons.

**Etiology:** Canine Distemper virus, suspect from vaccine

**Comments:** Central nervous system lesions in natural infection with Canine Distemper Virus are mostly in the white matter and consist of myelonic edema, demyelination and astrogliosis with gemistocytic astrocytes. The inclusion bodies are found in the nucleus and cytoplasm of astrocytes. The white tracts of cerebellar folia and the periventricular white matter are the most severely affected. The vaccine-associated infection is due to an attenuated strain of the virus that has retained virulence and causes primarily a polioencephalitis with necrosis in the pontine nuclei as seen in this case.

**References:**

Granulomatous meningoencephalomyelitis (reticulosis)

Clinical history: Repeated episodes of progressive neurological signs (circling, ataxia, hypermetric gait, depression) over a 5 month period in a 4.5 year old intact male Maltese dog.

Histopathology:

Brain: The sub gross examination of all brain sections shows multifocal blue areas within the meninges, the gray and the white matter. Microscopically, virtually all cerebral vessels and large proportion of the meningeal vessels are surrounded by very prominent, wide cuffs of lymphocytes and epithelioid type macrophages. Ratio of lymphocytes to macrophages vary, and often only one cell type is represented. Occasionally these granulomatous aggregates are not associated with an apparent central vessel. Choroid plexus remained uninvolved and it appears that the vessels of the white matter are more heavily involved than the vessels of the gray matter.

Cervical spinal cord: The vessels of the meninges, and particularly that of the pia matter are mutifocally surrounded by prominent cuffs of lymphocytes and macrophages. Similar to the brain, the white matter appears to be more heavily involved than the gray matter. Longitudinal section of the spinal cord reveals the existence of numerous, side-by-side arranged oval to round clear spaces (axonal loss) containing pink debris (myelin) with occasional cells containing abundant pink-gray vacuolated cytoplasm and oval nuclei (macrophages). These structures are interpreted as digestion chambers.

Morphological diagnosis: Granulomatous meningoencephalomyelitis (reticulosis).

Axonal loss and demyelination of the ventral tracts of the cervical spinal cord: mild.

Comments: Granulomatous meningoencephalitis (GME) is an idiopathic inflammatory disorder of the central nervous system that is believed to have an immunologic basis. GME occurs worldwide, most commonly in middle aged, female small breed dogs, especially poodles, small terriers, Pekinese and Maltese. Clinical signs vary depending on the area of the brain affected and the distribution of the lesions, and may include cervical pain, nystagmus, head tilt, blindness, ataxia, seizures, circling and behavior change. The course of the disease may be rapidly progressive and fatal within days, or may be more insidious, slowly developing over 1 to 4 months. Lesions are found in the meninges, brain and cervical spinal cord, and consist of gray-white discolorations of the white matter of the brain or spinal cord. Irregular areas of malacia may be appreciated in larger, more confluent lesions. On histology, perivascular aggregation of inflammatory cells consisting of predominantly lymphocytes and plasma cells with small eccentric clumps of macrophages is characteristic of GME. The number of macrophages may increase with time to form granulomas, with occasional mitoses and epithelioid transformation. The white matter is often more severely affected than the grey matter.

I would like to thank Hélène Philibert at the Western College of Veterinary Medicine for this case.

References:

Neuroschistosomiasis in a Swan

Clinical history: An adult Mute Swan housed with one other swan and several other waterfowl species was found dead with no observed premonitory signs

Histopathology:

Brain: Diffusely throughout the cerebellum, cerebrum and brain stem, large numbers of the small blood vessels of the grey matter and the meninges are dilated by a range of intraluminal structures. These blood vessels display marked endothelial hypertrophy and are often surrounded by lymphocytes, macrophages, multinucleated giant cells and occasionally granulocytic cells (eosinophils or heterophils). There is considerable variation in the appearance of the intravascular structures - many appear to be well-defined round to oval accumulations of brown strands and granules, others are poorly defined aggregates of brown granules often admixed with pyknotic nuclei, others appear to be round to oval accumulations of pink material which occasionally contains round vesiculated nuclei, and others appear to be large round to oval optically lucent vacuoles containing 1 to 3 round cells with abundant, foamy, eosinophilic cytoplasm and a single eccentric, round, vesiculated nucleolus (schistosome eggs in various stages of degeneration, some of which contain miracidium). Occasionally within the neuropil there are large round purple structures (mineralized schistosome eggs outside of vessels). Within the white matter of the brain and cerebellum there is also mild gliosis. In the eye, similar structures are common within the vessels of the choroid, also associated with a perivascular granulomatous inflammatory infiltrate.

Other lesions in this bird included: Severe fibrinonecrotic salpingitis; severe granulomatous pneumonia and airsacculitis with fibrosis and intracellular acid-fast bacteria; multifocal, moderate necrotizing hepatitis; and severe generalized amyloidosis.

Morphological diagnosis: Severe multifocal granulomatous vasculitis of the brain and eye with intralesional trematode eggs.

Ancillary test: PCR was performed on the brain using 18S small subunit ribosomal RNA gene primers. Based on the 1848 bases sequenced it was a 99% match with Dendritobilharzia pulverulenta.

Etiology: Dendritobilharzia pulverulenta

Comments: Dendritobilharzia pulverulenta is a freshwater trematode in the family Schistosomatidae that is found in a range of aquatic bird species. Adults are typically found in the arteries of the mesenteric, renal, cloacal and portal blood vessels with eggs in the mucosa of the intestine, occasionally causing a mild encephalitis. Neuroschistosomiasis, where eggs are located in the central nervous system is one of the most severe clinical outcomes of schistosomiasis in people, but is only very rarely reported in veterinary species. It results from aberrant migration of the adult trematodes to the brain or spinal cord with shedding of large numbers of eggs into the vessels of the brain with an associated inflammatory response. Dendritobilharzia pulverulenta has been once before been reported as a cause of granulomatous encephalitis in swans.

References:
Multifocal subacute necrotizing encephalomyelopathy in a Simmental calf

Clinical history: A 9-month old Simmental bull with a one month history of progressive, multifocal symmetrical neurological signs characterized by depression and weakness that was worse in the hind limbs than the front.

Histopathology:

There are focal, bilateral symmetrical areas (olivary nucleus) in the brainstem where there is marked depletion of the neuropil and vacuolation of myelin sheath. Vessels are prominent, with hypertrophy of endothelial cells and astrocytes are swollen. Scattered neurons are ill-defined and hypereosinophilic while other neurons are viable. Similar changes, but to a milder degree are seen in caudate nuclei, in grey matter along the third ventricle and aqueduct of Sylvius and in grey matter of spinal cord of thoracic region, just dorsal to spinal canal.

There was also a mild suppurative bronchopneumonia from which Pasteurella multocida was cultured.

Morphological diagnosis: Encephalomeyolomalacia, multifocal, bilaterally symmetrical, subacute, severe

Etiology: Unknown

Comments: Multifocal subacute necrotizing encephalomyelopathy (MNE) was first described in Australia in 1991 and in the USA in 1992. It is observed in 5 to 12-month old Simmental and Simmental-cross cattle, resulting in progressive ataxia and hindlimb paresis and occasionally behavioural changes such as hyperexcitability with bilaterally symmetrical grey, depressed cavitated foci involving the caudal olivary nuclei and other brainstem nuclei. The etiology is not known, but is suspected to be hereditary because of the strong breed predisposition. It has similar clinical and pathological features to Leigh’s Syndrome, a neurodegenerative condition affecting children due to a variety of inherited metabolic defects in mitochondrial enzymes.

Reference:

Subacute polioencephalomalacia in a steer

**History:** A 3 month old Limousin cross calf became acutely recumbent and showed neurological signs: flexing neck, strabismus, apparent blindness and occasional convulsions.

**Necropsy Findings:** The only significant gross findings were restricted to the brain. The cerebral cortex had diffuse fluorescence under U.V light.

**Histopathology:** Section of cerebrum. There is diffuse necrosis (neurons are angular, eosinophilic, shrunken) and loss of neurons in all layers of the cortex. In the superficial layer, neuropil is dense, hypereosinophilic, granular and there is proliferation of vessels, hypertrophy of endothelial cells (neovascularization) and perivascular and meningeal accumulation of macrophages. The deep layer neuropil is vacuolated (spongy) with perineuronal and perivascular dilation (intracellular astrocytic edema), and edema of the neuropil. The adjacent white matter in the corona radiata is pale staining with mild dilatation of myelin sheath.

**Ancillary tests:** Blood lead = 0.02 ppm; CSF tap: granulomatous inflammation; CSF bacterial culture: negative

**Diagnosis:** Subacute polioencephalomalacia, locally extensive, severe

**Etiology:** Suspect thiamine responsive polioencephalomalacia

**Comments:** The diagnosis of polioencephalomalacia when used in context of morphological changes can result from a range of factors that cause energy deprivation of neurons (lack of oxygen or glucose). In ruminants, these include thiamine deficiency, high sulfates in diet, water deprivation, lead poisoning, hypoglycemia and rarely cyanide and mercury poisoning. Polioencephalomalacia the disease is linked to thiamine deficiency, either by lack of production of thiamine by the ruminal microflora due to imbalanced diet that favor growth of thiaminase producing bacteria (diet high in carbohydrate, sulfates), or ingestion of thiaminase-containing plants. High sulfur in the food or water, without concurrent decrease of thiamine in the blood, can directly cause polioencephalomalacia in feedlot cattle.

**References:**

Meningoencephalitis with Disseminated Sarcocystosis In A Free Ranging Moose Calf

Madhu Ravi 1, Jagdish Patel 1 and Margo Pybus 2


Abstract: A wild moose (Alces alces) calf was euthanized due to severe neurologic signs. Grossly, there was unilateral hyphema and perirenal hemorrhages. Microscopic examination revealed meningoencephalitis with mature and immature schizonts in the vascular endothelium of multiple blood vessels of the brain. Morphologically similar parasitic stages with and without inflammation were also present in the lung, heart, kidney, uveal tract of eyes, mesenteric lymph nodes, spleen and small intestine. Immunohistochemistry (IHC) revealed strong positive reaction of parasitic stages to Sarcocystis spp. polyclonal antibodies. Gene sequencing of PCR amplified 18s ribosomal RNA identified the species as Sarcocystis alceslatrans in the brain tissue.

History: A female, six month old moose calf was submitted for necropsy. The animal was humanely euthanized by wildlife authorities due to severe neurologic signs of head tilt and uncoordinated gait with loss of awareness of surroundings.

Gross findings: The calf was in good body condition with shiny body coat. All the temporary incisors were present. Both corneas were clear and intact with no other visible gross lesions. There was mild hemorrhage in the anterior chamber of the right eye. Multifocal petechial hemorrhages were present on the cortical surface of both kidneys and in the peri-renal adipose tissues.

Histopathology - Brain stem (slide in the box): Microscopic examination revealed round to oval, 19-24μm x 18-23μm protozoan schizonts in different stages of maturation within the endothelium lining of multiple, small-caliber blood vessels and capillaries. Multiple small blood vessels and capillaries in the cerebral gray and white matter, midbrain, brainstem and cerebellum were cuffed and infiltrated with small numbers of lymphocytes, plasma cells and macrophages. There is multifocal gliosis and rarefaction of neuropil with hemorrhages extending from affected vessels. Neuronal necrosis was rare. Meninges were multifocally expanded with similar inflammatory infiltrate and a few meningeal blood vessels contained schizonts in the endothelial cells. Glial nodules and acute hemorrhages were present in the gray and white matter multifocally. Similar mature and immature schizonts with and without inflammation were also present in various parts of brain. Mature schizonts contained 2-3 μm x 1-2 μm, round to oval zoites. Immature schizonts contained a single multilobulated, basophilic nucleus. Protozoal stages positively reacted with PAS stain.

Morphological diagnosis: Brain stem - Meningoencephalitis, lymphoplasmacytic and histiocytic, multifocal, moderate with hemorrhage, rarefaction, vasculitis, gliosis and intralesional and intraendothelial protozoal schizonts

Comments: Morphologically similar protozoal stages with and without inflammation were present in endothelium of blood vessels in the heart, lung, uveal tract of eyes, kidneys, spleen, mesenteric lymph node and small intestine. Schizonts in the brain tissues strongly reacted to polyclonal Sarcocystis spp. antibodies, and partially reacted to Neospora and Toxoplasma antibodies. A mild to moderate positive reaction to polyclonal Neospora sp. and Toxoplasma gondii antibodies is not unusual reflecting some cross-reactivity between shared antigens of Apicomplexan group of parasites. PCR testing confirmed Sarcocystis alceslatrans in brain tissue. Although rare, acute clinical disease due to disseminated Sarcocystis spp. infection during vascular schizogonic cycle has been reported in cattle, alpaca and rhesus macaque. It is possible that this moose calf may have grazed and/or consumed water in an area heavily contaminated with wild canid feces containing infective cysts. Although uncommon, sarcocystosis should be considered in the differential diagnosis in moose exhibiting neurologic signs.

References:


Cervical spinal cord compression associated with vertebral osteomyelitis

Clinical history and gross findings:
3 month old calf. Very rigid muscles. Had good suck reflex, but could not stand. On necropsy, large abscess attached to the liver was found. Fibrin was present in several joints of the limbs. At the junction of C6-7, there was moderate amount of friable white material in the body of the spinal column, which protruded into the spinal canal and compressed the spinal cord (figure below). The spinal cord had a soft depression at the associated location on palpation.

Histopathology:
Spinal cord: There is frequent dilation of myelin sheaths with severely swollen axon. Occasionally, small numbers of macrophages are noted in the dilated myelin sheaths. The dura mater on the ventral side is infiltrated by moderate numbers of neutrophils and lymphocytes.

Morphological diagnosis:
Spinal cord:
1. Wallerian-like degeneration of white matter
2. Suppurative dural meningitis

Ancillary test:
The swollen axons stained positive for Holmes stain

Etiology:
Bacterial septicemia, with cervical osteomyelitis and subsequent spinal cord compression
Comments:

The initial cause of the hepatic abscess might be a naval infection, which could not be confirmed during gross examination. This animal was clear in septicemia, supported by the presence of fibrin in multiple joints. The vertebral osteomyelitis is also a result of septicemia. Bacterial culture was not performed.

Chronic compression of the spinal cord typically causes degeneration of the myelin and axons. Neuronal changes is not the dominant feature of this condition.

References:

NA
Spinal neuronopathy

Clinical history and gross findings:
6 weeks old Rottweiler puppy. Started to have trouble walking when she was 3-4 weeks old. She was normal before this time, walking, sucking normally. At 4 weeks old, owner noticed muscle weakness in hind limbs then shortly after front legs were also affected. Referral vet reported signs of lower motoneuron disease in all 4 limbs initially with poor reflexes which progressed to severe muscle disease. Mentation is normal. Normal cranial nerves.

On necropsy, the dog had very poor musculature of all four limbs. No other significant changes were noted grossly.

Histopathology:

Spinal cord: Frequently, there is degeneration of the neurons, especially those in the ventral horn of the spinal cord at all levels. Affected neurons have central to completely loss of nissl substances. The nuclei are frequently displaced peripherally. Rarely, multifocal lymphocytic inflammation is observed in the white matter of the spinal cord and in the grey matter of the brain stem.

Skeletal muscles from hind limbs (not included in the slide set): Multifocally and frequently, some myocytes are pale and small, making the myocyte sizes on the cross section greatly variable. There is frequently lining up and internalization of the nuclei (regeneration).

Morphological diagnosis:

Spinal cord: Neuronal degeneration, all level, ventral horn

Skeletal muscle: Denervation muscular atrophy and degeneration

Ancillary test:

NA

Etiology:

Not determined. Suspect hereditary (Familial motor neuron disease).

Comments:

The very young age onset, the clinical signs, the histological findings in the spinal cord, with predominant involvement of ventral horn neurons are suggestive of familial motor neuron disease. This has been reported in Rottweilers in 1987. However, Wallerian-like degeneration was reported to be prominent in the initial publication, which is not noted in the current case. Dr. Sue Taylor was the neurologist of this case. Her comments were "It seems there have been no clinical descriptions of this disease in the veterinary literature since the 1987 initial description. Odd for an inherited disease." (Taylor, email communication).
No neuromuscular signs were noted in the littermates of the case dog. Thus, whether this is a true hereditary condition is not determined.

References:

Bovine Spongiform Encephalopathy and Chronic Meningo-Encephalitis

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Clinical History
An approximately 6 month old Hereford/Angus heifer from the CFIA’s SPF herd was intracranially challenged with Classical BSE. 1 month after inoculation, the animal displayed an abnormal head position, mild to moderate depression, and mild fever. Antibiotic therapy was initiated, and over several days fever persisted and neurologic abnormalities progressed. These included head tilt, abnormal head position, and depression. Eventually the animal became recumbent and an opisthotonus was observed. Intravenous antibiotic therapy was continued over several weeks supported by physical therapy. The animal recovered, however, mild stiff gait and ataxia remained.

At approximately 17 months after the challenge, the animal displayed signs of clinical disease indicative of BSE, including moderate anxiety, being hyper alert in the pen with other animals, excessive response to light and sound stimuli, and progressive ataxia and dysmetria. The animal was euthanized at 20 months post challenge.

Histopathology
The H&E section examined at the level of the obex shows fibrous adhesions between the 4th ventricular surface to the cerebellum, and moderate atrophy of the cerebellar cortex. There is a multifocal loss of ependyma of the 4th ventricle and fibrosis in the same region. A mild to moderate gliosis is identified throughout the section, most severe dorsally and segments of choroid plexus are found trapped present within the fibrosis. There is loss of neurons at the dorsal contour of the section and the outline of this region of the brain is distorted. Mild to moderate neuropil vacuolation is present in all nuclei of this section, most prominent in the Trigeminal Nucleus and Nuclei of the Reticular Formation. Numbers of shrunken neurons are moderate and rarely intra-neuronal vacuoles are identified.

Morphological Diagnosis
Spongiform Encephalopathy
Chronic meningoencephalitis

Ancillary Test: Immunohistochemistry for Prion Protein
Moderate bilateral immuno-labelling for prion protein is identified throughout the section. Punctate neuronal staining is observed in the Trigeminal Nuclei and Reticular Formation. Granular and linear staining is present in multiple locations, including the Reticular Formation, the Trigeminal Nuclei, and Dorsal Motor Nuclei of the Vagus. Abundant staining of microglia is seen throughout.

Comments:
An abnormally folded form of a protein called the prion (PrPsc) is believed to be the cause for Bovine Spongiform Encephalopathy (BSE). Three variants of BSE have been characterized, since it was first
detected in the United Kingdom in 1986. The PrP<sup>Sc</sup> forms include classical BSE (C-type) and two atypical forms, high (H-type) and low (L-type). C-type can be transmitted through oral consumption of BSE contaminated feed. Oral challenges of H- and L-type BSE in cattle are still ongoing and results are not yet available. Transmission studies have been successful using intracranial (IC) challenge of all three types of BSE. The intent of this reported study was to determine if PrP<sup>Sc</sup> and its deposition in cattle would be impacted/modified/changed when passaged intracranially in bovines.

This reported animal developed clinical meningitis/meningo-encephalitis post challenge which was successfully treated. The animal remained clinically stable until signs of BSE occurred. Incubation period, clinical progression, histopathologic changes and immunohistochemical detection of prion protein was not different to other animals challenged with C-type BSE.

In this experiment, brain homogenate of three field cases of C-type and two cases of atypical BSE (one H-type and one L-type) of Canadian origin were used to intra-cranially inoculate Angus x Hereford calves. Immunohistochemistry (IHC) was performed on tissue sections using mAb F99/97.6.1 (VMRD) and 6C2 (CVI Lelystad). The areas of importance in the obex include the hypoglossal nucleus, the dorsal motor nucleus of the vagal nerve; the nucleus of the solitary tract; the nucleus of the spinal tract of the trigeminal nerve and the reticular formation. Areas examined in the Cerebellum include the outer and inner molecular layers, the Purkinje cell layer, the granular layer, and the deep cerebellar nuclei. Patterns and intensity of immunoreaction were characterized and graded.

Results showed that the neuroanatomical distribution and pattern of PrP<sup>Sc</sup> was similar within BSE types when comparing naturally infected animals and those which were intracranially challenged. Based on these data, we can confirm that intracranial challenge is an appropriate model for studying BSE pathogenesis.
Cerebral Babesiosis in a cow

Clinical history: Seven year-old Kittitian Creole with a six day history of anorexia, fever, lethargy and weakness. Clinical examination performed five days prior to death revealed pale and icteric mucous membranes and a PCV of 17%. The cow was treated with 12000mg of oxytetracycline IM and 400mg of flunixin IV. That evening the cow appeared slightly brighter and had some interest in forage. Dark red urine was observed on a Friday afternoon, approximately 30 hours before death. On Saturday she was still feverish and the PCV remained low (17%). The animal was given another dose of flunixin and 2500 mcg of cyanocobalamine IM. The cow was found dead on Sunday morning and submitted for post-mortem examination.

Gross post-mortem findings: The subcutaneous, intra-abdominal and intra-thoracic adipose tissues were diffusely yellow (icterus). Focal areas of hemorrhage were scattered within the muscles of the hind-limbs. The spleen was markedly enlarged (64 cm X 20 X 6 cm) and meaty with petechial and ecchymotic hemorrhages scattered throughout the capsular surface. The gallbladder was moderate distended with thick slightly granular dark-green bile. A moderate amount of dark red urine was present within the urinary bladder (hemoglobinuria) and petechiae were present throughout the mucosal surface of the bladder. Petechial hemorrhage was occasionally observed throughout the peritoneum and pleural surfaces. The surface of the brain appeared deep pink and wet (edematous) and there was diffuse congestion of the meningeal blood vessels.

Microscopic Findings (cerebellum & medulla): Sections of the brain were characterized by mild to moderate dilatation of Virchow-Robin spaces and occasional mild spongiform change within the perivascular neuropil (edema). Sludging of red blood cells was present within capillaries, especially within those of the cerebral cortex. Giemsa-positive, round to pear-shaped intracellular protozoa approximately 2 µ in the largest dimension, were demonstrated primarily within RBCs entrapped (agglutinated) within capillary lumina.

Morphological diagnosis: Cerebrum, blood vessels: Giemsa-positive intraerythrocytic protozoa compatible with Babesia spp.

Ancillary test: N/A

Comments: Most significant gross and histological findings in this cow were consistent with those of Babesiosis. Babesia organisms are protozoa of the phylum Apicomplexa which can parasitize the red blood cells of a wide range of mammals, including (rarely) humans. The disease in cattle is also known as Texas fever, red-water, piroplasmosis or tick fever.
Babesiosis is still quite prevalent in tropical and subtropical areas of the world but has been eradicated from the United States thanks to the successful control of the ixodid ticks that transmit the organisms. The typical clinical findings in severe cases are primarily the result of acute intravascular hemolysis, hypoxia and multi-organ failure. In countries in which hemoparasites like Babesia and Anaplasma spp are endemic the differential diagnosis of these diseases is occasionally based on parasite morphology and on the fact that hemoglobinuria is not a feature of anaplasmosis (intracellular hemolysis). Neurologic signs in humans and animals with babesiosis have been associated with the sludging of parasitized erythrocytes. The pathogenesis of the encephalopathy observed in cerebral babesiosis is not clear but it has been compared with the brain injury observed in people with neurologic complications of infections with Plasmodium falciparum (cerebral malaria). Parasite sequestration within the cerebral microvasculature is thought to be a central factor in a complex pathogenesis leading to endothelial injury and cerebral hypoxia.

References:


Focal suppurative meningo-encephalomyelitis secondary to *Rothia spp.*-induced otitis media/ interna in a cat

**Signalment:** 5-year-old female domestic shorthair cat

**Clinical history:** Patient had a 6-8 month history of progressive neurological signs (right sided ataxia, weakness, falling to the right side). Toxoplasma titers were negative

**Gross post-mortem findings:** The most relevant findings were confined to the head and the cranial cervical area. There was a large amount of brown waxy material (cerumen) in the right external acoustic meatus. In the oral cavity, and extending from the right pharyngeal area, there was a firm yellow mass approximately 4 cm in the largest dimension, filled with opaque, pale yellow exudate (abscess). The exudate extended into, and obliterated the right tympanic bulla leading to marked remodeling of the right temporal bone and compression of the right side of the cerebellum. The purulent exudate reached the foramen magnum causing compression of the cervical spinal cord. There was a focal relatively round area of malacia within the parenchyma of the right cerebellar hemisphere. No other gross lesions were present elsewhere.

**Microscopic Findings (cerebellum & medulla):** There is a round, relatively well-circumscribed area of inflammation, approximately 8 mm in diameter, which obliterates and compresses the normal architecture of the cerebellar folia and partially infiltrates the meninges and choroid plexus. This area of inflammation is composed primarily of neutrophils and lesser numbers of plasma cells, lymphocytes and macrophages and is partially surrounded by a pseudocapsule composed of epithelioid macrophages. The immediately adjacent and compressed cerebellar folia exhibit loss of neurons within the Purkinje and granular cell layers and diffuse spongiform change within the white matter. Multifocal perivascular aggregates of plasma cells, lymphocytes and macrophages are present in the neighboring less affected cerebellar parenchyma.

**Morphological diagnosis:** Chronic, focal, suppurative meningo-encephalomyelitis with cerebellar abscessation.

**Ancillary test:** Bacterial Culture revealed the presence of *Rothia spp.*

**Etiology:** *Rothia spp.*

**Comments:** Even though the specific species of Rothia was not determined, *Rothia dentocariosa*, a Gram-positive aerobic bacterium of irregular morphology found in the oral cavity of humans and animals appears most likely. It is possible that the offending microorganism reached the middle ear through residual periodontal and dental infection; however, no evidence of a tooth abscess was detected at the time of necropsy. The possibility that the port of entry could have been a bite wound cannot be ruled out. *Rothia dentocariosa* has been described as a rare cause of bacteremia, endocarditis and brain abscesses in humans.

**References:**
Necrotizing leucoencephalitis, suppurative, multifocal - with hemorrhage, edema, vascular fibrinoid necrosis and scattered neuronal necrosis and gliosis.

Clinical history: Four year-old female (intact) Rottweiler with an approximately 4-month history of neurologic abnormalities (right sided hemiparesis, slight depression, right sided menace deficits and seizures). Treated with steroids, mannitol and phenobarbital.

Gross post-mortem findings: The most relevant findings were confined to the brain. Within the right cerebral hemisphere which appeared swollen, and starting at the level of the frontal lobe and predominantly affecting the white matter, there was a poorly circumscribed area of malacia that extended caudally to the level of the caudate nucleus and the internal capsule. The cerebral white matter in these areas was markedly edematous and had multifocal areas of hemorrhage and necrosis. The meninges were diffusely congested and there was mild compression of the left cerebral hemisphere. No other gross lesions were present elsewhere.

Microscopic Findings (cerebellum & medulla): Within the right cerebral hemisphere, and predominantly confined to the white matter, there is effacement of the normal architecture due to multifocal areas of necrosis and discrete areas of hemorrhage. Rarely these lesions extend into the neighboring gray matter leading to neuronal degeneration and necrosis, evidenced by pyknotic neurons with shrunken and hypereosinophilic cytoplasm. Within the affected white matter there is scattered cellular and karyorrhectic debris, few mononuclear cells with abundant foamy cytoplasm (gitter cells) and perivascular and parenchymal infiltration by neutrophils, lesser numbers of lymphocytes, plasma cells, and occasional eosinophils. Transmural fibrinoid necrosis of the vessel wall is present within the areas of necrosis and prominent endothelial hypertrophy is usually observed in less affected blood vessels. In addition, diffuse edema and gliosis seen within the neighboring areas.

Morphological diagnosis: Necrotizing leucoencephalitis, suppurative, multifocal - with hemorrhage, edema, vascular fibrinoid necrosis and scattered neuronal necrosis and gliosis.

Ancillary test: Bacterial Culture of the CSF was negative (no growth)

Comments: The etiology of the leucoencephalitis observed in this dog remains unclear. The brain lesions are quite remarkable but do not seem to fit the neurologic syndromes which have been reported in Rottweilers. The presence of occasional eosinophils within the inflammatory infiltrate suggests the possibility of a parasitic condition.
References:


Neospora hughesi induced protozoal encephalomyelitis in a horse

Clinical history: In January 2007, a 10 year old Arabian cross horse was presented to a local veterinarian after being found stumbling on pasture. The horse was observed to have lost a considerable amount of weight. The horse was initially able to stand, but lost the ability to stand soon after. Within one day of presentation the horse began to thrash in his stall and had lost anal tone and the ability to move his tail. The horse was euthanized based on the presumed poor prognosis and lack of facilities to manage a recumbent horse. The horse had been on pasture for several months and was observed only infrequently by the owner.

Histopathology: Significant microscopic lesions were confined to the cervical spinal cord and brain stem. There were irregularly sized aggregates of lymphocytes circumferentially or multifocally in the superficial white matter of the cervical spinal cord and brainstem. Occasionally, lymphocytes accumulated around superficial blood vessels (perivascular cuffing). Focal areas of malacia were present in the neuropil surrounding these areas of inflammation. Multifocally, 10 to 20 μm, unencapsulated aggregates composed of multiple 2-4 μm diameter oval protozoal tachyzoites could be found both within and near areas of malacia

Morphological diagnosis: Multifocal lymphoplasmacytic myeloencephalitis with malacia and intralesional protozoal parasites.

Ancillary test: Immunohistochemistry for Neospora was positive, for Sarcocystis was negative. PCR and sequencing revealed 99% similarity to N. hughesi

Etiology: Neospora hughesi

Comments: Equine protozoal myeloencephalitis (EPM) is rare condition in Western Canada, but much more common elsewhere in North America. Two organisms are commonly associated with EPM, Sarcocystis neurona and Neospora hughesi. Of these two, S. neurona accounts for the majority of reported cases and the seroprevalence has been reported to be approximately 20x higher than N. hughesi (1). Relatively little is known about the life cycle of N. hughesi, the definitive host has not been identified, nor have other details about the life cycle been reported. Seroprevalence rates suggest that infection is more common in summer months and much less common in the winter (1). Seroprevalence has been reported in horses in both North and South America, Europe, Asia and New Zealand, but no other clinical reports of EPM caused by N. hughesi have been reported in Canada (2).

EPM can present with a variety of signs depending upon the location of the lesions within the CNS, but the most common clinical signs are ataxia and weakness. These signs can be sudden in onset or more insidious, in either case they tend to progress. Definitive diagnosis is tricky in the living horse and often requires sampling of the CNS tissue and is therefore typically performed following euthanasia.

This case is unusual for many reasons including the rarity of EPM in Saskatchewan, the lack of travel history of this horse into the United States and the occurrence in the middle of winter.

References:

Case 35 (D1307375)  
Michael Pawlik

Meningeal Worm in a Moose

Clinical History:
A 2.5 year old, female moose was found at the edge of a farm, alone and unable to stand.

Histopathology:
Brain:
Embedded within the white matter of the brain, beneath the cerebellum, are several sections of a parasitic nematode. The worm has a thin, smooth cuticle, an indistinct hypodermis, coelomyarian musculature, a medium sized digestive tract with a wall comprised of a few multinucleated cells, and gonads. There are infrequent tracts in other areas of the brain which are characterized by haemorrhage, swollen axons and rarefaction of the neuropil. Vessels in the brain and the meninges are often cuffed by lymphocytes and plasma cells. The lumen of one of the meningeal arterioles is occluded by a thrombus.

Morphological diagnosis:
Brain: Encephalomalacia, acute, multifocal, haemorrhagic with intraliesional nematode and perivascular, lymphoplasmacytic infiltrates

Ancillary test:
None

Etiology:
*Parelaphostrongylus tenuis*

Comments:
The white-tailed deer is the natural, definitive host of the meningeal worm. When white-tailed deer are infected they are often asymptomatic. However, when a non-adapted host species (e.g. moose) becomes infected the larval migration is aberrant causing significant damage to the brain and spinal cord. Within the definitive host the adult worm sits on top of the dura mater where it deposits eggs. When the first stage larvae emerge they enter the circulatory system and travel towards the lungs. Upon entering the lungs the parasite is coughed up and swallowed. The larvae are then passed into the environment via defecation. Here they get picked up by the intermediate host, a gastropod. Whilst in the gastropod, the larvae develop into the infective third stage. The gastropod is then consumed by the definitive host wherein the larvae emerge and migrate towards the brain, thus completing the lifecycle. Affected animals will often exhibit a loss of coordination, an abnormal gait, circling, a heat tilt, paresis and paralysis. An infection in a non-adapted host is often fatal. At present, the parasite can be found throughout Eastern and Central Canada as far as the east side of Saskatchewan. However, the white-tailed deer are expanding their range westward in response to environmental changes. In consequence the parasite has been introduced to new areas causing mortalities among related species. Other methods of diagnosis include detecting specific parasite antigens with ELISA and demonstrating first stage larvae in the feces. However, aberrant hosts rarely shed eggs.

References:
http://www.usask.ca/wcvm/herdmed/specialstock/deer/Ptenuis.html
Rabies virus infection in a striped skunk

Clinical history:
A skunk was found near a slough, wandering around in circles and frothing at the mouth.

Histopathology:

Brain:
Vessels of the brain and meninges are cuffed by a moderate infiltrate of lymphocytes, plasma cells and macrophages. Cerebellar Purkinje cells and neurons throughout the hippocampus, cerebrum and thalami are characterized by one or more of the following changes: margination of Nissl substance (degeneration), cytoplasmic hypereosinophilia, nuclear pyknosis, cellular fragmentation (necrosis) and one or more round, eosinophilic, intracytoplasmic inclusions (Negri bodies). Glial cells are more numerous in affected areas (gliosis).

Trigeminal Ganglion:
Neurons of the trigeminal ganglion often contain one or more, round, intracytoplasmic, eosinophilic inclusions (Negri bodies) and exhibit degenerative changes similar to those described in other sections of the brain (necrosis). Affected neurons are surrounded by dense aggregates of lymphocytes, plasma cells and macrophages. Axons of the trigeminal nerve exhibit vacuolization of the myelin sheath (Wallerian degeneration).

Adrenal Gland
The vessels in and around the corticomedullary junction are fairly prominent (congestion). There are multiple aggregates of lymphocytes, plasma cells and macrophages around vessels and within the interstitium of the adrenal medulla.

Salivary Gland
There are multiple, mild to moderate interstitial infiltrates of lymphocytes, plasma cells and macrophages throughout the section. There is a random distribution of glandular epithelial cells characterized by cytoplasmic vacuolization (degeneration), cytoplasmic fragmentation and nuclear pyknosis (necrosis) with eosinophilic, intracytoplasmic inclusions (Negri bodies). The adjacent epithelium is often attenuated. Numerous acini of the salivary gland are distended with accumulations of mucinous material.

Morphological diagnosis:
Acute, generalized, neuronal necrosis with intracytoplasmic viral inclusion bodies and lymphoplasmacytic and histiocytic, perivascular cuffing (Rabies)
Acute, diffuse, necrotizing, lymphoplasmacytic salivary adenitis with intracytoplasmic viral inclusion bodies (Rabies)
Acute, multifocal, lymphoplasmacytic and histiocytic adrenalitis (Rabies)

Ancillary test:
None
**Etiology:**
Rabies Virus (Lyssavirus)

**Comments:**
Rabies Virus is an enveloped, single stranded, negative sense, RNA virus. There are many strains of the virus, each of which is adapted to a particular reservoir host. With the exception of Antarctica and New Zealand, rabies is worldwide in its distribution. However, in many countries, like Australia, Japan and the United Kingdom, the virus is only found in bats. Virtually all mammalian species are susceptible to the disease which is almost always fatal. Transmission of the virus typically occurs through the bite of an infected individual as the virus is shed in the saliva. However, transmission may also occur via the contamination of a pre-existing wound, via contact with mucous membranes and via inhalation if the virus is aerosolized. Once the virus enters the body it replicates in local tissues. Depending on the location of the bite the time it takes to reach the brain will vary. With a bite to the face the virus can reach the brain in as little as 10 days. The virus then replicates in neurons causing neuronal degeneration and necrosis. Once the virus establishes in the CNS it travels towards the salivary gland via the peripheral nerves, wherein it is shed in the saliva. Peripheral dissemination is not limited to the salivary glands and the virus may be detected in a number of other tissues. Clinical signs usually develop within 30-50 days of exposure. However, in some cases the disease can take years to manifest. The disease will present in one of two forms: “Furious” and “Dumb”. The furious form of the disease is characterized by anxiety, irritability, increased aggression, unusual behaviour (e.g. loss of fear of humans) and terminal paralysis. The dumb form of the disease is characterized by a loss of coordination and paralysis. Ancillary tests can be used to confirm the diagnosis. Tests include virus isolation, RT-PCR, immunofluorescence and ELISA on serum (non-vaccinated) or cerebrospinal fluid.

**References:**
Fibrocartilaginous emboli in a dog.

**History:**

Acute onset, progressive, non-painful hind limb paralysis. Owners noticed no problem before Thursday night when dog got out of car and couldn't use hind limbs. Referred to WCVM from Kenora Ontario (high rate of blastomycosis.) Physical examination unremarkable. Neurological examination found normal to slightly decreased reflexes in the hind limbs. Normal front limbs. Normal cranial nerves with the exception of a postional rotary nystagmus. Chest and abdominal radiographs noted suspected pulmonary osteomas and an irregular spleen. Spinal survey radiographs did not find any abnormalities. Abdominal ultrasound found heterogenous, enlarged spleen. FNA of spleen was normal tissue. CBC, Chem, UA, PT/PTT all unremarkable. CSF taps from the A/O and lumbar regions were normal. MRI of the brain with contrast was unremarkable. MRI of the lumbar spine found extensive intramedullary hyperintensity. The cord appeared normal in size and compressive lesions were not evident. The LS junction showed mild compression at the disc space. Dog is well vaccinated, lives with 6 other dogs and 7 cats. No history of trauma, injury, or previous illness. Rescued from a reserve as a puppy and lived with this family his whole life.

**Gross findings:**
The disks at the level of L5, L6 and L7 appeared dry and fragmented. A mild protrusion of the disk at the level of L7 was seen; however, no gross evidence of disk rupture or spinal cord compression was seen.

**Histological description:** Spinal cord (lumbosacral area): Within the gray matter and extending multifocally into the white matter are areas of necrosis characterized by loss of parenchymal cells and neuropil, and replacement with eosinophilic cellular and basophilic karyorrhectic debris, admixed with hemorrhage and gitter cells (infarcts). Multifocally, vessels within the gray and white matter are often occluded by a pale, amphophilic, acellular material (fibrocartilaginous emboli). Within the white matter adjacent to necrotic areas, there are a few dilated myelin sheets containing pale eosinophilic swollen axons (spheroids) or gitter cells (digestion chambers) (Wallarian degeneration). Multifocally within the neuronal cytoplasmic processes are a few oval amphophilic to basophilic bodies measuring 10-20 micrometers in diameter (Lafora bodies). There are multifocal areas of dural ossification.

**Comments:**

Fibrocartilaginous embolic myelopathy usually occurs as a sequel to degenerative disk disease in dogs. Clinical signs of acute, severe, spinal cord damage similar to that associated with type I herniations of intervertebral disks are often seen. However, the syndrome is generally associated with type II herniations and is most common in nonchondrodystrophic dogs of large and giant
breeds. Areas of swelling, malacia, and hemorrhage are seen within the spinal cord on gross examination. Microscopically, venules and/or arterioles in areas of malacia contain fibrocartilaginous material, originating from degenerate nucleus pulposus. The mechanism by which material from the nucleus pulposus enters the spinal vasculature is not known. Venous emboli can be explained by the herniation of nuclear material into the overlying venous sinus. Arterial emboli may pass through arteriovenous communications from the venous circulation. Alternatively, they may directly penetrate arterioles in the degenerate annulus fibrosus and be extruded up to the radicular artery, from where they could gain access to the spinal cord. The possibility that such emboli develop following prolapse of the nucleus pulposus into the marrow cavity of an adjacent vertebral body has also been suggested.


Spinal Astrocytoma in a Cat

Dr. Jolanda Verhoef
Dr. Brenda Bryan

Clinical History:
An 11y MN DSH, showed chronic, progressive neurologic symptoms of left sided hemiparesis and weight loss. CT of head and spinal radiographs were within normal limits.

Gross Necropsy:
A focal, red to brown pale discoloration of the left aspect of the spinal cord with mild swelling at the level of the mid cervical vertebrae C6 and the caudal aspect of C7 (1.5cm in length) was present. On section of the cord, there was a focal, approximately 3mm diameter, pale grey well delimited mass that occupied the center of the cord at the level of C6. The mass continued caudally and expanded into the left side and compressed the right side of the cord. More caudally, the cord appeared normal with a focus of malacia and the whole cord is replaced by this grey mass which appeared to reach C8.

Histopathology:
There is a round, well, delimited, non-capsulated mass that is compressing up to 95% of the surrounding tissue at spinal cord segment 5 and 6. The cell population is mostly composed of round to polyhedral cells with well-defined cell borders, and a finely granular eosinophilic cytoplasm. The nuclei of these cells are round, central to eccentrically located and have finely stippled chromatin with a single nucleolus. Less commonly, there are spindle shaped cells with indistinct borders, a central or peripheral oval to irregularly round nuclei, with a similar stippled chromatin pattern and single nucleoli. There is moderate anisocytosis and anisokaryosis. The cells are arranged in sheets, streams and pseudo rosettes. Mitoses are approximately 10-15 per HPF. There is various amounts of Wallerian degeneration at the tumor periphery and multi-focal necrotic foci with cholesterol crystals.

Morphologic Diagnosis:
Gemistocytic astrocytoma.

Ancillary Test:
GFAP-IHC (glial fibrillary acidic protein) weakly positive with increased staining at the tumour periphery.

Comments:
Spinal tumours occur infrequently in cats with astrocytomas reported rarely. Lymphomas are recognized as the most common intradural neoplasia in the feline spinal. Of the spinal cord gliomas in cats, astrocytomas are considered the most common. Astrocytomas have been well described in humans as well as canines, bovines and felines. In general, astrocytomas have a predilection for intracranial sites with spinal cord astrocytomas being the most uncommon. They are all malignant forms of neoplasia, but display variation in malignancy based on amount of pleomorphism, cellular organisation, presence of necrosis, mitotic index.

References:
Thoracolumbar tumor of the spinal cord in a young dog

History: A 21-month-old male, intact Rottweiler dog was presented to the Veterinary Medical Centre with a 3-day history of hindlimb paralysis. Bilaterally, there was loss of deep pain in the hindlimbs. MRI revealed a tumor at the level of tenth thoracic vertebra (T10). The patient was euthanized and was presented for postmortem examination.

Necropsy Findings: The dog was in good body condition with adequate adipose tissue stores. The spinal cord at the level of T10 had a subdural, approximately 1.5 X 1 cm mass present on the left side encompassing roots of spinal nerves. The affected segment of the spinal cord was firm on palpation. On cut section, the mass extended into the white and the gray matter of the spinal cord.

Histopathology: Spinal cord: Effacing the normal gray matter and the majority of the white matter and extending unilaterally into the subdural space is an unencapsulated, well-delineated, highly cellular neoplasm composed of three cell populations. The epithelial component is predominant and consists of numerous acini or tubules with frequent invaginations forming glomeruli-like structures. The epithelial cells are cuboidal to low columnar with moderate eosinophilic cytoplasm, round to oval nuclei, stippled chromatin, 1-2 nucleoli, moderate anisocytosis and anisokaryosis. There are rare groups of polygonal cells with minimal cytoplasm and high nuclear to cytoplasmic ratio (blastemal cells). Mesenchymal component is minimal and consists of loose embryonic connective tissue. Mitotic figures are approximately 60 per ten 400X fields. There is a rim of white matter at the periphery which consists of multifocally dilated myelin sheaths containing swollen eosinophilic axons (axonal spheroids).

Immunohistochemistry: 1) WT-1 (Wilm’s tumor gene product): Focal aggregates of small proportion of neoplastic cells forming glomeruli-like structures had positive nuclear staining.
2) Cytokeratin: Cells forming acini or tubules were positive.
3) Vimentin: Spindle cells within the mass stained positive but epithelial cells forming tubular structures were negative.
4) GFAP (Glial fibrillary acidic protein): Neoplastic cells were negative.

Diagnosis: Spinal cord nephroblastoma or Thoracolumbar tumor of the spinal cord
Comment: The World Health Organization recommended name is “Thoracolumbar spinal cord tumor of young dogs” as the histogenesis of this tumor has not been completely established yet and it typically affects T10-L2 segment of the spinal cord of the young, large-breed dogs. The other commonly reported names are spinal cord nephroblastoma or Wilms' tumor based on histological features and positive immunohistochemical staining for WT-1. Nephroblastomas are embryonal tumors reported either as primary renal tumors (arising from the primitive metanephric blastema) or as spinal cord tumors in young dogs (thought to arise from nephrogenic rests trapped in the spinal cord duramater). The tumor in this case had histological features of a nephroblastoma with a predominance of epithelial component. Neoplastic cells were immunohistochemically positive for cytokeratin, WT-1 and were negative for GFAP.

References:


Listeriosis in a goat

History: An 8-month old French alpine doe presented for assessment due to depression and recumbency. She had been found standing alone and depressed 48 hours earlier. Initial therapies administered by the owner included thiamine and penicillin. Despite treatments the doe progressively deteriorated and was admitted for evaluation.

Clinical examination: At presentation to the WCVM, a neurological examination revealed multiple asymmetric central nervous system deficits (e.g. increased jaw tone and salivation; reduced palpebral reflex, strabismus and drooping of ear on right side, head tilt (right), nystagmus etc.) which were localized to the brain stem based on involvement of multiple of cranial nerves and a change in mentation. Initial clinical pathology diagnostics revealed erythrocytosis, hyperfibrinogenemia, lymphocytosis and mature neutrophilia, with a mild regenerative left shift. Euthanasia was recommended due to deterioration in clinical signs in spite of therapy.

Gross exam: Necropsy examination revealed diffuse congestion of leptomeninges. On cross section, the brain stem was affected by marked congestion and multifocal pinpoint hemorrhages. There were occasional random white malacic areas (1-3 mm in diameter) surrounded by a hyperemic ring.

Histopathology: The brain stem and associated meninges were affected by severe chronic lymphoplasmacytic perivascular inflammatory infiltration accompanied by multifocal random neutrophilic and histiocytic infiltrates (microabscesses) associated with liquefaction and rarefaction of neuropil. This severe inflammatory process is accompanied by marked glial cell reaction (microgliosis, astrocitosis and astrogliosis) and neuronal necrosis and axonal swelling together with activation of endothelial cells and prominence of capillaries.

Morphological diagnosis: Chronic ongoing lymphoplasmacytic meningoencephalitis with suppurative encephalitis (microabscessation) in the brain stem.

Bacteriology: *Listeria monocytogenes* was isolated from a swab taken from the brain stem.
Final diagnosis: **Cerebral Listeriosis**

**Comment and recommendation to the owner:** Cerebral Listeriosis is a consequence of an ascending infection along the trigeminal nerves and subsequent inflammation of adjacent nuclei in the brain stem. Since Listeriosis is a zoonotic disease appropriate precautions should be undertaken. Both sick and clinically normal animals may shed the bacteria in both milk ad feces for prolonged periods, and can survive long periods during low temperatures. Unpasteurized milk and milk products therefore should not be consumed. It was recommended to the owner that any animal suspected of Listerosis in the future should be treated with long acting oxytetracycline, with appropriate meat and milk withdrawals.