Neurology
Case log #13
December 14, 2022
Lyla GR2669211

**Signalment and history**

Lyla, an 8.9yr old, spayed female, mixed breed canine, presented to the neurology service at BluePearl Pet Hospital for vestibular symptoms, which began acutely two months prior. Symptoms included leaning and stumbling to the left, weakness, and vomiting. The patient (pt) remained static after onset. Lyla had developed a firm mass on the left side of her face in August, which had not been aspirated. She had no other significant medical history. Current medications included maropitant 48mg (2.18mg/kg) PO q24h PRN for prevention of emesis and PO prescription heartworm, flea, and tick prevention. Core vaccinations were up to date.

**Patient on presentation**

On presentation, Lyla was alert and responsive and weighed 22.0kg. Her heart rate (HR) was approximately 90 bpm with synchronous femoral pulses, respiration rate (RR) was 20 rpm with normal respiratory effort, and her temp was 100.6°F. There was a 4 cm, firm, and irregular chain of SQ tissue on her left mandible, which was freely moveable. No evidence of otitis externa was observed. On neurological assessment, Lyla had mild cerebellovestibular ataxia and a tendency to veer left when gaiting. Attempts at turning right were resisted and worsened her ataxia. Her posture when standing was wide-based in all four limbs, with normal tone and weight-bearing, a mild left body lean, and left head tilt. No cranial nerve deficits or obvious postural reaction delays were observed. Localization was cerebellovestibular (hindbrain). Problem list included central vestibular disease.

**Veterinarian's differential diagnosis and initial assessment of prognosis**

Differential diagnoses included neoplasia (most likely), otogenic bacterial encephalitis/empyema, infectious or autoimmune encephalitis (less likely), and vascular event

(unlikely). Initial prognostic assessment was guarded without a definitive diagnosis. Neoplasia of the central nervous system carried a guarded prognosis. Prognosis with encephalitis was dependent on etiology but overall fair. A vascular event carried a good prognosis.

**Interventions**

The DACVIM-Neurology (DACVIM) ordered an MRI. A recent CBC and serum biochemistries performed by Lyla's primary veterinarian (pDVM) were unconcerning. The client declined three view thoracic radiographs, which were offered to screen for evidence of metastasis. An 18-gauge IV catheter was placed, and the applicant implemented an anesthetic protocol, providing pre-oxygenation flow-by to the patient, and giving butorphanol (10mg/mL) at 0.1mg/kg (2.2mg, 0.22mL) and midazolam (5mg/mL), at 0.1mg/kg (2.2mg, 0.44mL) IV for pre-anesthetic sedation. Anesthesia was induced with propofol (10mg/mL) at 3.64mg/kg (80mg, 8.0mL) IV, given slowly to effect. The pt was intubated and maintained at 1.0% isoflurane on a pneumatic mechanical ventilator throughout the procedure, with a RR of 10 rpm. Isotonic crystalloid fluids were given at 5mL/kg/hr (110mL/hr). The applicant monitored vitals throughout the procedure, including HR (55-70 bpm) and rhythm (ECG normal), BP (65-85 mmHg mean arterial pressure [MAP]), pulse quality (strong and synchronous with ECG), pulse oximetry (96-100%), and capnography (end-tidal 30-35 mmHg, normal waveform). Spontaneous nystagmus was noted upon induction, but otherwise, anesthesia was uneventful.

Routine MRI scans of the brain were performed in three planes, and gadolinium (287 mg/mL) contrast was given IV at 57.4 mg/kg (1,262.8 mg, 4.4 mL) for additional imaging. The MRI revealed a large mass within the fourth ventricle with a multifocal cystic appearance and strong contrast enhancement. Vasogenic edema, brainstem and cerebellar displacement, and mild

obstructive hydrocephalus of the lateral and third ventricles were present secondary to the mass. Primary differentials were choroid plexus tumor (CPT) or ependymoma (EPM). The pituitary gland was also enlarged and extended rostrally, an incidental finding that was concerning for a pituitary macroadenoma (PMA). Following MRI, a 1.0cm biopsy was taken from the mandibular mass and sent for histopathological evaluation, which was consistent with a fibroma and considered benign.

**Treatment and case management**

Treatment options for Lyla included palliative care versus oncology referral for radiation or chemotherapy, and/or surgical resection. The client elected palliative care. Lyla was prescribed prednisone 10mg (0.45mg/kg) PO q24h to reduce perilesional edema and reduce CSF production. The DACVIM approved adjustments to this dose as needed, depending on clinical symptoms and side effects. To prevent worsening obstructive hydrocephalus, omeprazole 20mg (0.9mg/kg) PO q12h was prescribed for additional reduction of CSF production.

Lyla was discharged from the hospital following MRI and anesthetic recovery. At the time of discharge, the applicant communicated important factors involved in care and management of a patient with brain disease, including crate rest when unsupervised to avoid injury and walking on the left side of the patient to support the body lean. Symptoms of progressive brain disease to monitor for at home were also discussed, including seizure activity, inappropriate mentation, vision loss or impairment, and abnormal changes in balance, posture, gait, and/or behavior. While the DACVIM was happy to re-examine Lyla as needed, further rechecks were not necessary. Instead, follow-ups were performed over the phone and email, with the client providing updates due to the palliative nature of care. Seven days later, the client

reported that Lyla's symptoms had improved, but she had developed polyuria/polydipsia (PU/PD and the client was planning to cut the steroid dose in half. The applicant recommended instead a 25% reduction of prednisone (7.5mg [0.34mg/kg] PO q24h) for several days, stating that if Lyla continued to be asymptomatic on the lower dose, the client could then try giving 5mg (0.23mg/kg) PO q24h. The applicant informed the owner that if at any time Lyla began to decline, the prednisone dose should be increased to the previous dose, and the neurology team contacted. Attempts to contact the client for updates went unanswered for four weeks. The client then reported to emergency staff, while the neurology team was out of the office, that she had been giving Lyla 5mg (0.23mg/kg) of prednisone PO q12h, but despite this, Lyla was "declining at home". Further details were not provided. The dose was increased to 10mg (0.45mg/kg) PO q12h at the recommendation of an emergency clinician. After that adjustment, the client was once more lost to follow-up. When contacted, the pDVM's office had no new information.

**Final Outcome**

One month after the last communication with Lyla's owner, and approximately eight weeks after diagnosis, it was reported that Lyla had been euthanized with her pDVM due to progressive neurological disease and poor quality of life. Necropsy was not performed for a definitive diagnosis.

**Discussion**

An ependyma is a single layer of cells, remnants of the neural tube, that form during fetal development, which line the ventricles of the brain and the central canal in the spinal cord (Skerritt, 2018, p. 217). At certain points within each ventricle, the ependymal layer and adjoining pia mater become proliferated with capillaries to form a dense structure known as the

choroid plexus (CP). These structures are responsible for the production of CSF and provide a barrier separating the CSF from the blood within the brain (De Lahunta et al., 2014, p. 11-12).

Neoplastic tumors, called ependymomas (EPM), may develop in both the ependyma of the spinal cord or any of the four ventricles of the brain. Ependymomas are uncommon and predominantly intraventricular; however, aggressive anaplastic EPMs may expand and distort the ventricular cavity, leading to obstructive hydrocephalus, while also invading the adjacent parenchymal tissue of the brain. Ependymomas typically occur in older animals with no particular breed being predisposed (Wisner & Zwingenberger, 2015, p. 223).

On the other hand, tumors that arise from the choroid plexus (CPT) are relatively common in dogs, particularly in Golden Retrievers, although any breed may be affected. Diagnosis often occurs earlier than that of other intracranial tumors, with six years being the average age at time of diagnosis (Wisner & Zwingenberger, 2015, p. 223). Because of the intimacy between the CP and ependymal tissues and similar imaging characteristics, distinction between CPT and EPM can be difficult, as was the case with Lyla. The research in this report is primarily focused on CPT of the fourth ventricle.

Canine CPT may be classified as benign choroid plexus papillomas (CPP) or choroid plexus carcinomas (CPC), which are more likely to invade brain parenchyma and tend towards malignancy, with metastasis often occurring intraventricularly or intrathecally (Wisner & Zwingenberger, 2015, p. 223). In dogs, an estimated 7%-10% of primary brain tumors are CPT (Antonakakis et al., 2022). Approximately 50% of those originate from within the fourth ventricle (Wisner & Zwingenberger, 2015, p. 223), which extends dorsally into the base of the cerebellum. Due to the proximity of the CP ventrolateral to the cerebellum, evidence of

cerebellar compression or displacement may be observed clinically. On Lyla's imaging, displacement of both the cerebellum and brainstem was observed. As a result, she exhibited vestibular ataxia, as well as abnormalities of her head and body posture.

The CSF departs the ventricular system from the fourth ventricle, emptying through the lateral apertures of the ventricle, and entering the subarachnoid space, from which it circulates around the brain, spinal cord, and central canal. Maintaining normal intracranial pressure (ICP) depends on the lateral apertures in domestic animals because it is the only conduit between the subarachnoid space and the ventricular system (De Lahunta et al., 2014, p. 54). Hydrocephalus and increased ICP are common consequences of CPT of the fourth ventricle, as expansion of the mass often occludes one or both of these apertures, causing dilation of the ventricles due to CSF accumulation. Severely increased ICP can lead to herniation of the cerebellum through the foramen magnum, which can be fatal as the herniated tissue compresses the caudal brainstem and cranial cervical cord. Lyla's MRI showed mild hydrocephalus, suggesting the CPT only partially obstructed the lateral aperture in this case.

An MRI was utilized in this case as it allows superior delineation of the intracranial structures over CT and is generally considered the gold-standard modality for imaging the brain. Neoplasia was the DACVIM's top differential; therefore, the CPT on Lyla's MRI was somewhat expected. These tumors appear hyperintense on transverse-relaxation-time-weighted sequences (T2w). On longitudinal-relaxation-time-weighted sequence (T1w) scans, CPT may be hyper-, iso-, or hypointense and show significant, uniform contrast enhancement due to the vasculature associated with the CP and tumor arising from its tissues (Wisner & Zwingenberger, 2015, p.

223). The most unusual finding on Lyla's MRI was the presence of a pituitary mass, which was unexpected as she had not exhibited obvious symptoms of pituitary dysfunction.

While not performed in this case, an article published in 2023 suggests CSF analysis of pts with CPT may show elevated total protein, as well as marked mononuclear pleocytosis; these findings may also indicate meningoencephalitis and are not considered diagnostic without further evidence (Schneider et al., 2022). However, CSF evaluation may provide value in differentiating CPC from CPP. Schneider et al. (2022) cite a study conducted over 22 years and published in 2007, which found that CSF protein of greater than 80 mg/dL has been demonstrated to be significantly associated with CPC and that atypical cells are identified in approximately 50% of CPCs (Westworth et al., 2008b).

Veterinary medicine has yet to establish universal protocols for the treatment of CPTs (Antonakakis et al., 2022). As with other intracranial neoplasms, surgical resection, chemotherapy, and/or radiation therapy may be considered. Moreover, little comparative information is available as to the survival time of dogs treated with these modalities (Rossmeisl et al., 2013). These more aggressive treatments are frequently foregone in favor of palliative care, the goal of which is to improve the quality of life of both pts and owners. Prognosis for animals palliated for primary brain tumors is poor, with a median survival time of 69 days past diagnosis (Rossmeisl et al., 2013). While not specific to CPT, a 2013 study published in the Journal of the American Veterinary Medical Association compared the average survival time of palliated dogs with supratentorial tumors versus that of dogs with infratentorial tumors and concluded that dogs with infratentorial lesions, like Lyla, had a mean survival time of 28 days. Whereas the dogs in the study with supratentorial neoplasms had a significantly longer survival

time of 119 to 270 days (Rossmeisl et al., 2013). Lyla was euthanized two months after her diagnosis.

Often, the use of corticosteroids is favorable to reduce perilesional vasogenic edema when present, and the anti-inflammatory effects may also benefit animals without significant edema. In some cases, a transient reduction of tumor size occurs with corticosteroid therapy. Corticosteroids also have the potential to reduce production of CSF, which may be of particular benefit when obstructive hydrocephalus is present, as with Lyla (Miller et al., 2019). Proton pump-inhibiting drugs, most notably omeprazole, are also commonly used to decrease CSF production, as they inhibit the enzymes responsible for secreting fluids, such as stomach acid and CSF.

While follow-up with Lyla's owners was sparse, it was reported that she was "declining at home". No specifics were offered. Worsening vestibular ataxia, anorexia, and vomiting would all be reasonable based on the location of her lesion. Other brainstem and/or cerebellar dysfunction was also assumed, which could have significantly impaired Lyla's mobility. Obstructive hydrocephalus can lead to forebrain signs, such as seizures, vision loss, worsening anxiety, and pacing behavior. As ICP increases and compresses the cerebellum, herniation through the foramen magnum may occur, a fatal complication due to compression of respiratory centers in the brainstem and cranial cervical spinal cord. It is presumed Lyla was euthanized before this occurred.

This case represents a common presentation and management of a somewhat uncommon neoplasm of the central nervous system. The applicant's advanced skills in anesthesia and advanced imaging protocols allowed the DACVIM to diagnose the patient and form a treatment

plan for palliative care. The applicant's advanced knowledge of this disease allowed for safe anesthesia of a patient with brain disease, and provided not only information but comfort to the client as she prepared for Lyla's end-of-life care.

**References**

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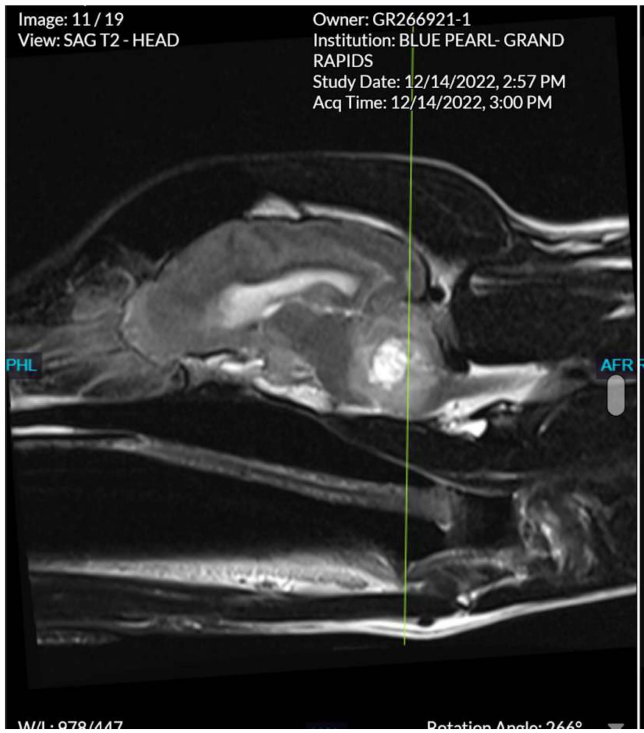
## Appendices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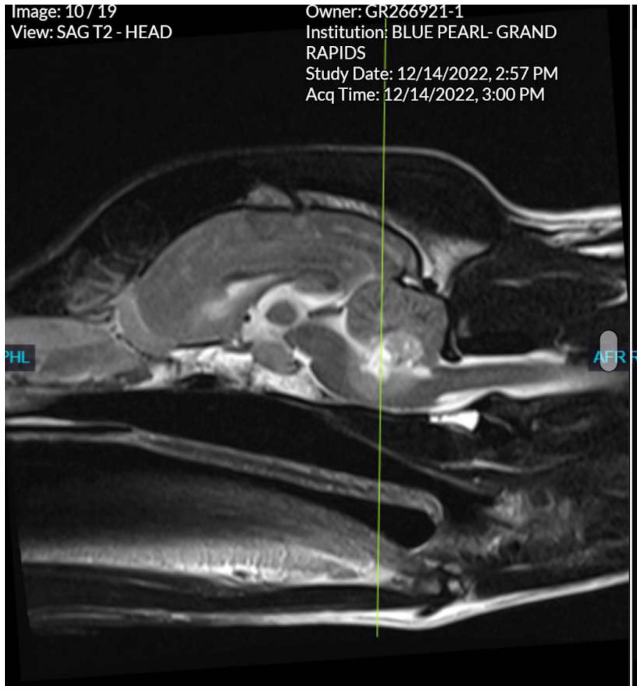
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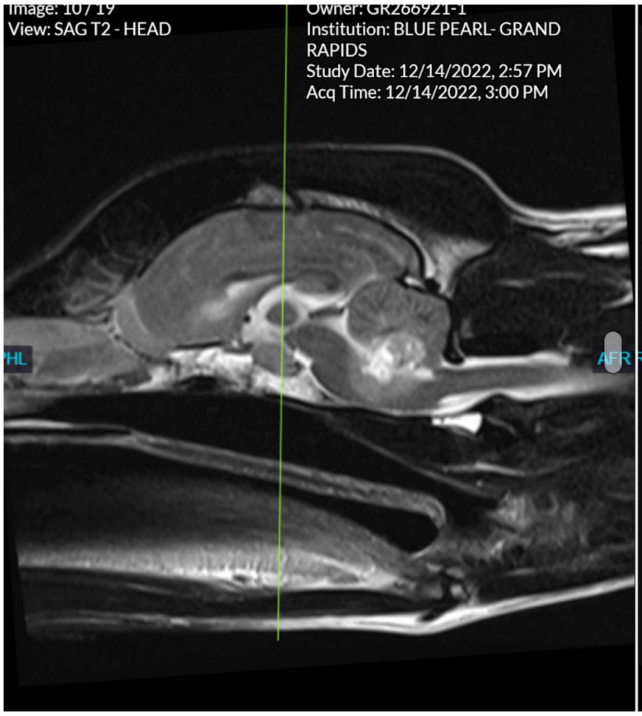
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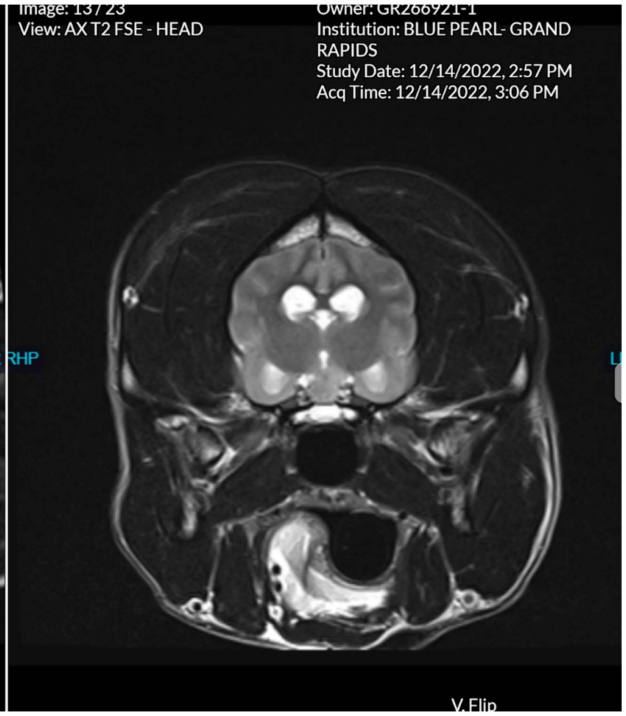
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