Crazy Cats: Neurologic or Normal?

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Feline neurology is very interesting but can be quite challenging. Cat brains and spinal cords are much smaller than in dogs, and subtle lesions are not always detectable on imaging. It is not uncommon to get normal diagnostics in cats with obvious neurological abnormalities. The frequency and prognosis for neurological diseases in cats are often different from dogs. Tables 1, 2, and 3 list neurological diseases of the brain, spinal cord, and neuromuscular system that affect cats. The most common disorders are described in more detail below the tables.

Table 1. Causes of brain disease in cats

Very common

- Vascular events (infarcts, hemorrhages)
- Meningiomas

Common

- Lymphoma
- Metabolic disease
    - Uremic encephalopathy
    - Diabetes mellitus/diabetic ketoacidosis
    - Hyperthyroidism
- Infectious
    - Feline infectious peritonitis
    - Otitis media-interna with intracranial extension
    - Bacterial abscess
- Idiopathic vestibular disease
- Toxicity—pyrethrins/permethrins

Less common

- Thiamine deficiency
- Infectious—cryptococcosis, toxoplasmosis

- Idiopathic epilepsy

Rare

- Other neoplasia
- Other infectious disease (FeLV, FIV, *Bartonella*)
- Congenital malformations
- Degenerative diseases and storage diseases

Table 2. Causes of spinal cord disease in cats

Very common

- Vascular events

Common

- Feline infectious peritonitis
- Spinal lymphoma
- Intervertebral disc disease
- Vertebral neoplasia (osteosarcoma, chondrosarcoma)

Less common

- Fracture/luxation
- Toxoplasmosis
- Cryptococcosis
- Bacterial myelitis

Rare

- Other neoplasia (glioma, meningioma)
- Other infectious disease (FeLV, FIV, *Bartonella*)
- Congenital malformations
- Degenerative diseases and storage diseases

Table 3. Causes of neuromuscular disease in cats

Common

- Metabolic disease
  - Hypokalemic myopathy
  - Diabetic neuropathy
  - Hyperthyroidism
- Lymphoma
- Ischemic neuromyopathy (i.e., saddle thrombus)

Uncommon

- Myasthenia gravis (congenital and acquired)
- Immune-mediated polyneuritis
- Nerve sheath tumor
- Toxoplasmosis
- Toxicity—organophosphates

Rare

- Congenital neuropathies and motor neuron diseases
- Congenital myopathies
- Dysautonomia

VERY COMMON

Vascular Disease

Vascular disease is very common in cats, likely due to the high frequency of cardiac disease, hyperthyroidism, hypertension, and renal disease in the feline population—all of which can predispose to infarct and hemorrhage. Vascular disease typically occurs in middle-aged to older cats but can occur at any age. The hallmarks of vascular disease are a peracute onset of neurological signs that stabilize or improve. Lateralizing signs are very common. Clinical signs reflect the location of the infarct. Cerebral infarcts can cause seizures, circling/pacing, decreased vision, and abnormal behaviors. Infarcts in the brainstem can cause obtundation, tetraparesis/hemiparesis, ataxia, vestibular signs, and various cranial nerve abnormalities (i.e., facial paralysis, decreased facial sensation, decreased gag, anisocoria). Cerebellar infarcts cause a hypermetric/dysmetria ataxia with little paresis or mentation change. Vascular events are a common cause of myelopathy, although they occur less commonly

than infarcts to the brain. Spinal cord infarcts are typically non-painful, although discomfort is occasionally reported.

Vascular events are best visualized using an MRI; however, not all infarcts are visible. In some cases, an MRI is not recommended due to the risk for anesthesia in geriatric cats with concurrent diseases. If I strongly suspect an infarct, I will often wait 24–48 hours before recommending an MRI to watch for clinical improvement. If a cat decompensates during that time, a vascular event is much less likely, and it is warranted to look for another underlying disease that may require a specific therapy. In some cases, a single dose of anti-inflammatory dexamethasone sodium phosphate (0.1–0.2 mg/kg) is helpful to treat perilesional edema from an infarct or hemorrhage, but chronic steroid therapy is not necessary. I avoid using more than a single dose of dexamethasone in a suspected stroke patient, because it makes it difficult to assess whether they are improving naturally or from the steroid.

The prognosis for recovery depends on the location of the infarct and the severity of damage. Cats with infarcts in the brainstem are typically much slower to recover given the importance of the brainstem for mental alertness and ambulation. Cats with severe lesions in the spinal cord may remain nonambulatory for an extended period of time. Large infarcts in the cervical spinal cord can lead to respiratory compromise by damaging the spinal cord segments supplying the phrenic nerve, which allows movement of the diaphragm.

I typically recommend reassessing cats with suspected infarcts every couple of days in the first week and then weekly thereafter. If there is no improvement after one week, recovery will likely be very slow or incomplete. I try to caution against making any permanent decisions (i.e., euthanasia) hastily, as I have been shocked at how dramatically some cats can recover given time.

Meningiomas

The vast majority of feline intracranial tumors are meningiomas. Feline meningiomas are quite benign; they grow very slowly over months to years. They are typically quite large at the time of diagnosis, because the surrounding brain is so slowly compressed that clinical signs are not noted until the meningioma is large enough that there is no longer any room for the surrounding brain to accommodate it. Owners typically notice subtle symptoms for weeks prior to presentation; however, clinical signs can come on very acutely. Clinical signs depend on the location of the tumor, the majority of which occur in the cerebrum. Cerebellar meningiomas are less common.

Meningiomas are best visualized using an MRI; however, they can be seen easily on a CT scan due to their strong contrast enhancement. Surgical debulking/resection is recommended for most meningiomas to relieve compression on the brain. Surgery can be curable in many cases. With incomplete resections, tumor regrowth is typically so slow that neurological signs do not recur for several months to years. Radiation therapy is an option for the rare meningioma that is not surgically resectable. In situations where surgery or radiation isn't financially feasible, many cats can do well for weeks to months with prednisone alone.

COMMON

Lymphoma

Lymphoma is the second most common CNS neoplasia. CNS lymphoma is typically multicentric/metastatic, but it can be primary or occur secondary to local extension from the nasal cavity, oral cavity, or middle/inner ear. Neurological signs reflect the location of disease but are often multifocal. Changes can often be seen on an MRI affecting the meninges, brain parenchyma, pituitary gland, or spinal cord, although a normal MRI does not rule out lymphoma. Diagnosis of CNS lymphoma is typically made by identifying neoplastic lymphocytes in the CSF. Treatment of CNS lymphoma involves chemotherapy with a combination of prednisone and CCNU or cytarabine (both of which penetrate the blood-brain barrier). Radiation is an option for focal lymphoma. Prognosis is variable. Some cats respond extremely well while others show minimal improvement. Survival time is usually 3–6 months depending on the severity of disease, although some can live longer.

Otitis-Media Interna with Intracranial Extension

In some cases, otitis media-interna causes significant inflammation and bony destruction to break through the skull and spread into the brainstem. Cats can present with acute or chronic signs, and some deteriorate quickly due to the increased intracranial pressure associated with the infection. Treatment for OMI with intracranial extension is surgery (typically ventral bulla osteotomy) to drain the abscess and long-term antibiotic therapy (6–8 weeks). Broad-spectrum antibiotics with good brain penetration (combination of Clavamox, marbofloxacin/levofloxacin, and metronidazole) are recommended while waiting on culture results. Prognosis is good with aggressive management.

Feline Infectious Peritonitis

CNS FIP typically occurs as the non-effusive "dry" form with little to no peritoneal involvement. Approximately 25–33% of cats with non-effusive FIP have neurological

abnormalities; 80% of affected cats are <3 years of age. Cerebellar/vestibular signs are most common; however, seizures and spinal cord dysfunction may also occur. FIP causes dramatic meningeal and ventricular inflammation, which can cause obstruction of the ventricular system and hydrocephalus.

Diagnosis of CNS FIP is extremely challenging. Necropsy is the only definitive diagnostic test. Meningeal/periventricular inflammation may be evident on MRI. CSF typically contains marked elevations in protein and white blood cells, but it may be normal. CSF titers to FECV/FIP are not useful, as they can be positive whether or not CSF infection is present and negative with active CNS FIP infection. PCR has limited sensitivity in CSF and brain samples.

Neurologic FIP is fatal, and treatment is supportive only. Anti-inflammatory doses of corticosteroids may help improve neurologic signs in the short term.

Head Trauma

Head trauma happens commonly secondary to vehicular accidents, fights, and falls/kicks (accidental or intentional). Consequences of head trauma include edema, hemorrhage, and fracture with or without shearing of brain tissue depending on the force and speed of impact. Many cats with head trauma will look very severe initially and improve with time and supportive care. Medical management for head trauma involves administration of mannitol where increased intracranial pressure is a concern (0.25–1 g/kg; with 1–2 repeat doses to no more than 2 g/kg total). Steroids have no beneficial effects in head trauma patients and can actually impede recovery. Treatment for seizures is strongly recommended if indicated, as further seizure activity can increase intracranial pressure. If brain compression from hemorrhage or fracture occurs, advanced imaging (CT or MRI) and surgical decompression may be required. Prognosis is generally good for cats that are not in a comatose state. The prognosis for cats in a coma (no response to noxious stimuli) is extremely poor.

Intervertebral Disc Disease

While much less common than in dogs, both acute and chronic intervertebral disc disease occur in cats. IVDD occurs most commonly in overweight, indoor cats. The most frequent site of herniation is L4–5, which is very different from dogs where 80% of disc herniations occur in the thoracolumbar region. Acute and chronic lumbosacral IVDD is a common cause of reluctance to jump, low tail carriage, and difficulty urinating/defecating. Cervical IVDD in cats is extremely rare. IVDD in cats is best diagnosed with an MRI. Treatment involves surgical decompression in cases with moderate to severe spinal cord compression.

Conservative management with rest and anti-inflammatory doses of prednisolone (2.5–5 mg SID to BID) are options in cats with minimal gait deficits or pain only.

Less Common

Cryptococcosis

Cryptococcosis is the most common fungal CNS disease. Cryptococcosis typically causes meningitis and can form cyst-like masses that compress the brain. Neurologic signs often suggest problems in multiple regions of the brain. With systemic cryptococcosis, infection in the eyes, skin, and nose is common.

Diagnosis of cryptococcosis involves MRI to identify specific lesions, and CSF analysis that may show varying types/severity of inflammation and occasional cryptococcal organisms. The gold standard diagnosis for cryptococcosis is the latex cryptococcal antigen test (LCAT) using serum and CSF.

Treatment for cryptococcosis involves long-term antifungal therapy using a combination of antifungal medications (amphotericin B, flucytosine, fluconazole). Anti-inflammatory doses of corticosteroids are useful in the initial treatment period to reduce inflammation.

Prognosis is guarded. Cats who respond to treatment are typically treated for months to years. Discontinuation of treatment can be attempted in neurologically normal cats after documentation of two consecutive negative LCATs. Recurrence can occur in some cats, and LCAT should be monitored periodically.

Toxoplasmosis

Toxoplasmosis rarely causes diffuse encephalitis in cats, and neurologic signs are variable. CNS involvement occurs in approximately 96% of cats with histopathologically confirmed toxoplasmosis, and concurrent ocular changes (i.e., anterior uveitis) are common. In cats with neurological signs alone, the infection is more likely reactivated than acute. The best diagnostic test is *T. gondii* brain immunohistochemistry followed by muscle/nerve biopsy and PCR. *Toxoplasma* antibodies are common in many cats with exposure to *T. gondii* and do not indicate active infection in many cases. Documenting a single IgM titer of >1:64 or four-fold increase in IgG titers taken 2–3 weeks apart is supportive of active *T. gondii* infection. Treatment involves clindamycin, potentiated sulfa drugs, +/- pyrimethamine for several weeks to months. Prognosis is variable.

Thiamine Deficiency

Thiamine deficiency affects highly metabolic areas of the brain including the thalamus, caudal colliculi, and vestibular nuclei. Neurological deficits reflect damage to these locations and can include seizure, compulsive pacing/circling, and vestibular signs. Signs are often acute and may be preceded by a period of vomiting or decreased appetite. Thiamine deficiency occurs more commonly in cats than in dogs and is seen with thiamine-deficient diets, high fish diets, and diets with sulfite preservatives. Diagnosis is made by documenting bilaterally symmetrical lesions on an MRI and ruling out other metabolic and toxic causes (the other top differentials for bilaterally symmetrical lesions). Documenting low thiamine levels in the food further supports the diagnosis. Treatment involves parenteral and oral thiamine administration. Prognosis is good with appropriate treatment, although some animals with significant brain necrosis at the time of diagnosis do not recover.

Epilepsy

Primary epilepsy is rare in cats. Recurrent seizures typically occur secondary to primary brain disease (i.e., neoplasia, infection, vascular disease) or a metabolic problem (i.e., poorly controlled diabetes mellitus). Long-term seizure management is recommended for any cat with recurrent seizures. The most commonly used anti-seizure medication in cats is phenobarbital (7.5 to 15 mg q 12–24 hours), which typically controls seizures well with few side effects (sedation and ataxia are most common). I prefer oral Keppra in cats, particularly those with concurrent systemic diseases, because it does not affect the liver or interfere with metabolism of other drugs as phenobarbital does. The starting dose for Keppra is 20 mg/kg, and it should be administered TID to be most effective. Keppra is available in an injectable form that I use in hospital for cats that are not eating. Zonisamide is another option for cats at doses of 3–5 mg/kg q 12–24 hours. Most cats will use the 25-mg capsule size. Diazepam is a good long-term anticonvulsant in cats but is used infrequently due to reports of fatal hepatic necrosis. Potassium bromide should not be used in cats, as it can cause a fatal pneumonitis.

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