Cerebrovascular Accidents in Dogs

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Dr. Filippo Adamo & his dog Pancio

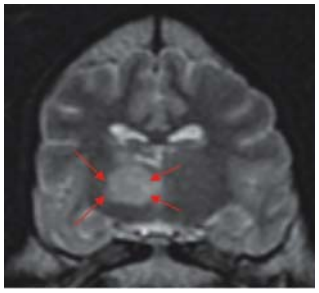
Editor's Note: *Please refer to Issue 1 of 2010 for Dr. Adamo's bio.*

Introduction
Cerebrovascular accidents (CVAs) are the third leading cause of death following neoplasia and cardiovascular disease in humans. Cerebrovascular accidents were previously considered to be uncommon in dogs and cats, but with the more recent advances in neuroimaging in veterinary medicine, including Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), CVAs are now recognized more frequently. Given recent increases in reporting and awareness, CVAs should be included in the list of differential diagnoses in an animal with an acute onset of progressive or nonprogressive brain disease. Cerebrovascular accidents include focal or global ischemic encephalopathies. These involve interruption of perfusion to the brain parenchyma, resulting in neuronal injury, which may lead to transient or permanent neurologic dysfunction.

Focal Ischemic Encephalopathy
A "stroke" or brain infarction is a focal encephalopathy secondary to a CVA and resulting in neurological deficit of sudden onset. Brain infarction can result from arterial or venous disease, however because of abundant venous anastomoses, venous infarction is uncommon in dogs.

The Causes of Strokes Can Be Divided Into Basic Groups

1. Obstruction of the blood vessels, leading to infarction. The obstruction may result from thrombosis and embolism. Thrombosis is defined as vascular obstruction developing within the occluded vessels. Embolism is defined as occlusion of a vessel by a fragment of blood clot or other substance that has flowed to the site of obstruction from a distant location.



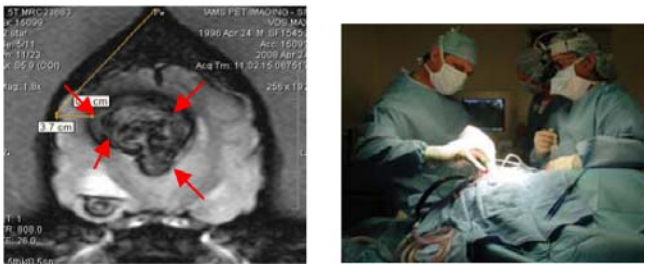
MRI of a 10 year old mix-breed dog with a paramedian thalamic infarct (red arrows). The dog presented with acute onset of pacing, circling and behavioral change. Clinical signs resolved spontaneously over 6 weeks.

2. Rupture of blood vessels walls, leading to hemorrhage. Intracranial hemorrhage is classified as intraparenchymal, epidural, subdural, and intraventricular.

An additional form of focal ischemic encephalopathy is the transient ischemic attack (TIA), which is a well-recognized vascular disorder in humans. TIA is a symptomatic episode of a brief focal, neurologic deficit secondary to embolism, vascular constriction or spasm that resolves within 24 hours, with 90% of spasms resolve usually within the first 4 hours. This form of vascular event is also believed to occur in animals but is seldom recognized and difficult to document.

Global Ischemic Encephalopathy
Hemodynamic compromise can result in decreased global cerebral perfusion. The most common potential causes of global ischemic brain damage include severe hypotension, advanced pulmonary disease, cardiopulmonary arrest, diffuse cerebral edema, or an anesthetic accident with insufficient oxygen delivery to the brain. Areas of the brain most susceptible to global ischemia include cerebral and cerebellar cortex, thalamus, hippocampus, and some basal nuclei.

Cerebral Hemorrhage/Intraparenchymal Hemorrhage
In the author's experience, intraparenchymal supratentorial hemorrhage is the most common form of intraparenchymal hemorrhage occurring in dogs and cats. Hemorrhagic infarction results in immediate extravasation of proteins with both vasogenic and eventual cytotoxic formation. In addition, ongoing hemorrhage may lead to focal space-occupying lesions, resulting in a mass effect with compression and ischemic necrosis of surrounding brain parenchyma. When the hemorrhage and the consequent hematoma becomes severe enough to cause a mass effect within the brain parenchyma, the outcome may be fatal.



MRI of a 12-year-old Mix German Shepherd, presented in semi-coma. The MRI showed a large intraparenchymal cerebral mass (red arrow) suggestive of hemorrhagic infarct. Dr. Adamo performed the removal of the mass, confirming a diagnosis of a large hematoma. The dog had a full recovery over the following 2 months, 2 years post-surgery the dog is still neurologically normal

The brain hematoma initiates edema and neuronal damage the surrounding parenchyma. Fluid begins to collect immediately around the hematoma, and edema usually persists for 5 days to 2 weeks. The release and accumulation of osmotically active serum proteins from the clot are responsible for the early edema around the hematoma. This is followed by vasogenic and cytotoxic edema, which in turn contribute to the further disruption of the blood-brain barrier, the failure of the potassium/sodium pump, and the death of neural tissue. The delay in the breakdown of the blood-brain barrier and the development of cerebral edema after intracerebral hemorrhage suggest that there may be secondary mediators of both neural injury and edema. It is commonly believed that both blood and plasma products are the mediators of most of the secondary processes initiated after intracerebral hemorrhage. Several observations have suggested that the genesis of a local hyperfibrinolytic state leads to the development of an expanding hematoma. Elevated levels of fibrinogen

degradation products have been demonstrated. Immature blood vessels in the capsule of the hematoma are poorly formed. These vessels may leak erythrocytes into the hematoma or be more likely to bleed secondary to minimal trauma. This low grade persistent hemorrhage is perpetuated by the anticoagulant, fibrinolytic environment; this process is the primary mechanism for hematoma expansion. Daily hemorrhage of up to 10% of an existing hematoma volume has been demonstrated.

Subdural Hematoma - Subdural space is the virtual space located between the inner dural layer and the arachnoid. (Figure 3) Traumatic laceration of veins crossing this potential space is the usual cause of acute subdural hematoma (SDH) formation in people. The time between a traumatic event and the development of clinical signs of intracranial dysfunction is inversely related to the severity of cerebral and vascular damage sustained at the time of injury. Acute SDHs are often accompanied by cerebral contusion and laceration, and can be rapidly life threatening. Chronic SDHs are often associated with a minor traumatic episode that may have been forgotten by the time the patient develops clinical signs. Subacute SDHs have an intermediate pattern of development of clinical signs. Small SDHs in people usually completely resolve, leaving only a residual membrane, which represents the residual capsule. Larger hematomas tend to undergo clot lysis, become encysted, and may subsequently show a tendency to expand. In people, SDHs are classified into four categories according to the time elapsed between the traumatic incident and the onset of clinical signs: hyperacute, acute, subacute, and chronic. SDHs in dogs have been rarely reported. SDHs may expand following the same mechanism described for the intraparenchymal hemorrhage.

Epidural & Intraventricular Hematoma - Epidural hematoma is usually associated with traumatic brain injury in which the buildup of blood occurs between the dura mater and the skull. Hematoma expansion may occur similar to the same mechanism described above. Intraventricular epidural hematoma tend to be spontaneous and are events rarely reported in animals.

Incidence & Risk Factors - Incidence - The true incidence of CVA in animals remains still unknown at this time, and there is no reported breed predilection. Risk Factors: Hyperfibrinogenemia, polycythemia, and multiple myeloma have been identified as cause of increased blood viscosity in both humans and dogs. In one study, several dogs diagnosed with idiopathic focal cerebral or cerebellar infarction were treated long term with phenylpropanolamine. Underlying conditions such as chronic renal failure and hyperadrenocorticism may predispose dogs to brain infarction or hemorrhage and should be screened for in animals with a suspected vascular event. Suspected risk factors for the development of global ischemia during anesthesia include brachicephalic conformation and the use of ketamine for induction and maintenance of anesthesia. Most cases of global ischemia may be the result of predisposing factors for the patients to cardiopulmonary arrest, idiosyncratic anesthetic reactions, insufficient anesthetic monitoring, or excessive anesthetic dosing.

Etiology - The cause of primary intraparenchymal hemorrhage is not completely understood, but in human's patients is frequently associated with hypertension with concurrent fibrinoid degeneration of cerebral arteries.

Cerebral Infarction - Brain infarction in dogs and cats is typically nonhemorrhagic; however, in the author's experience hemorrhagic infarction is not uncommon. The most common causes of arterial cerebral infarction are atherosclerosis (usually secondary to hypothyroidism, hyperlipoproteinemia or idiopathic), sepsis, neoplasia, Dirofilaria immitis, heart disease, and vasculitis.

Cerebral Hemorrhage - Hemorrhagic infarction has been associated with many underlying conditions including hypertension (usually secondary to renal diseases, hyperadrenocorticism, or idiopathic), coagulopathies, metastatic or primary central nervous system neoplasia, vascular malformation, amyloid angiopathy and idiopathic causes, and less commonly to arterial thrombosis and embolism.

Clinical Signs - Clinical signs are variable and are related to the specific cerebral area affected (forebrain: cerebral cortex and thalamic structures; brainstem: midbrain, pons or medulla oblongata; or cerebellum), the type (global or focal, ischemic or hemorrhagic) and the extension of the lesion. Clinical signs are usually acute in onset focal, asymmetric and non progressive. However, progression of the clinical signs and worsening of the neurologic deficits can be seen up to 24 to 72 hours following the initial infarction. Cerebral hemorrhage may be an exception to this description and can present with a more progressive course.4 Clinical signs in ischemic encephalopathy usually regress after 24-72 hours; this is most likely due to edema resorption. Clinical signs secondary to cerebral hemorrhage may take longer to regress and are secondary to hematoma, hemorrhage and edema resorption. Seizures are reported to be very common in association with CVA in dogs.4 With brain hematomas, seizures, dementia and comas are common signs.

Diagnosis - Imaging studies of the brain including CT and MRI are necessary to confirm the suspicion of a CVA and to rule out other intracranial diseases. Computed tomography is very sensitive for acute hemorrhage, with a linear relationship demonstrated between CT attenuation and hematoma hematocrit. The periphery of the lesion may enhance on CT imaging from approximately 6 days to 6 weeks after onset. MRI findings correlate well with the age of a hematoma and the onset of related symptoms. Characteristic MRI intensities allow for determination of the age of hemorrhage based on biochemical transformation of oxyhemoglobin (hyperacute stage) to deoxyhemoglobin (acute stage) to methemoglobin (subacute stage) and to hemosiderin (chronic stage). The MRI appearance of intraparenchymal and SDH brain hematomas in dogs has been previously reported.
A minimum data base including: CBC, serum biochemistry panel, urinalysis, thyroid function testing (TT4, fT4, TSH), coagulation profile (PT, PTT, fibrinogen degradation products), and multiple systolic blood pressure measurements should be evaluated in any animal suspected of having a CVA. A fecal analysis should also be performed to rule out parasitic infestation and blood and urine should be cultured if sepsis is suspected. Cerebrospinal fluid (CSF) analysis is seldom indicated to confirm the diagnosis but may help to rule out infectious or inflammatory diseases. CSF abnormalities associated with CVAs may include xanthochromia, increased protein, and a mild neutrophilic or mononuclear pleocytosis.

Treatment & Prognosis - There is no specific treatment for ischemic encephalopathy or for most type of intraparenchymal and subarachnoid hemorrhage. In the acute phase of a CVA particularly when the clinical signs are severe, the goal of treatment is to maintain good cerebral perfusion pressure (cerebral blood flow). This is achieved via the maintenance of systemic blood pressure, providing good oxygenation, controlling seizures if present, and removing the underlying cause when detected. In the immediate period following a suspected stroke, including cerebral hemorrhage, mannitol therapy (0.5-1 g/kg body weight) is warranted to combat brain edema. There is no evidence that glucocorticoid therapy provides any beneficial effect to human stroke victims. The outcome of patients affected by CVA depends on the extension and the localization of the lesion, the severity of clinical signs, and the underlying etiology.
Most cases of cerebral infarction improve over a few days to weeks. Intraparenchymal, intraventricular and subarachnoid hemorrhage may also cause reversible signs, but the severity of the clinical signs are often more severe. In large intraparenchymal, subdural or subarachnoid hematoma, if the clinical signs do not improve despite medical therapy, surgical evacuation of the hematoma should be employed, this may be a life saving treatment and may reverse the clinical signs.