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What Is Your Neurologic Diagnosis?

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Acute-onset seizures in a geriatric dog

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History

A 12-year-old male entire Maltese crossbreed without previous history of seizures was presented for cluster seizures lasting from 5 to 9 minutes 3 days prior to referral. The dog had no known trauma or exposure to toxins. On the second day following seizure onset and subsequent to a longer seizure lasting 9 minutes, diazepam was administered rectally (0.5 mg/kg). Due to unrest, this was followed by diazepam administered IM (0.5 mg/kg) and initiation of

Neurologic Examination Form

Observation

Mental	Alert		Depressed		Disoriented	x	Stupor		Coma		
Posture	Normal	x	Head tilt		Tremor		Falling		Other		
Gait	Normal		Ataxia		Pelvic limbs		All 4		Circling	x	
Paresis	Pelvic limb		Tetra		Hemi	x	Mono				
Other											

Key: 4 = Exaggerated, clonus; 3 = Exaggerated; 2 = Normal; 1 = Diminished; 0 = None; NE = Not evaluated.

Postural reactions	**Left forelimb**	**Right forelimb**	**Left hind limb**	**Right hind limb**
Wheelbarrow	2	2		
Hopping	2	1	2	1
Extensor postural thrust			NE	NE
Proprioceptive positioning	2	1	2	1
Hemistand/walk	2	1	2	1
Placing–tactile	2	2		
Placing–visual	2	2		

Spinal reflexes	**Left forelimb**	**Right forelimb**	**Left hind limb**	**Right hind limb**
Quadriceps			2	2
Extensor carpi	2	2		
Flexion	2	2	2	2
Crossed extensor	0	0	0	0
Perineal			2	2

Cranial nerves

	L	R		L	R
II, VII-Vision menace	2	1	VIII-Nystagmus, resting	0	0
II, III-Pupils resting	2	2	VIII-Nystagmus, change	0	0
Stim L	2	2	V-Sensation	2	2
Stim R	2	2	VII-Facial mm	2	2
II-Fundus	NE	NE	V, VII-Palpebral reflex	2	2
III, IV, VI-Strabismus, resting	0	0	IX, X-Gag	2	2
III, IV, VI, VIII-Strabismus, position	0	0	XII-Tongue	2	2

Comments
Dazzle reflex present bilaterally. Normal physiological nystagmus.

Sensation (Locate and describe any abnormalities)

Hyperesthesia	0	
Superficial pain	2	
Cutaneous reflex	2	
Deep pain	NE	

antiepileptic treatment with imepitoin PO at 12 mg/kg twice daily without effect. The dog was referred to an emergency service on the third day following seizure onset. On admission, the dog was apathetic, walked compulsively and into objects, and circled to the left **(Supplementary Video S1)**. Postural reactions and proprioception were mildly decreased in the right limbs. The dog also displayed a decreased menace response on the right.

Formulate your anatomic and etiologic diagnoses, then continue reading.

Assessment

Anatomic diagnosis

The presence of seizures, abnormal mentation, a decreased menace response in the right eye with a normal pupillary light response, circling to the left, and mild postural deficits on the right indicated a contralateral lesion in the left forebrain.

Likely location of the lesion

The most likely single location accounting for the clinical signs was the left forebrain (prosencephalon).

Etiologic diagnosis

Considering the age of seizure onset in this dog and presentation with acute onset cluster seizures and neurologic deficits, structural epilepsy was deemed likely. Differential diagnoses included vascular accidents, neoplasia (primary such as meningioma, gliomas, or choroid plexus tumors or secondary such as metastatic) and inflammatory disorders (bacterial, viral, protozoal, or immune-mediated meningoencephalitis). A traumatic origin was unlikely due to no stated history of trauma (and no signs thereof on clinical examination). Other causes of seizures such as metabolic (hepatic encephalopathy or electrolyte disorders), toxic, or degenerative disease were deemed less likely due to the asymmetrical neurologic deficits. High-field MRI (1.5 Tesla Vantage Elan; Canon Medical Systems) of the head was performed following stabilization. Acquired sequences included T2-weighted (T2W) transverse, sagittal, and dorsal planes and T1-weighted (T1W) transverse planes prior to IV administration of a contrast agent (*gadoteric* acid as a meglumine salt). Diffusion-weighted imaging and susceptibility-weighted transverse images were obtained in transverse planes prior to contrast administration. Postcontrast T1W sagittal and 3-D magnetization-prepared rapid acquisition with gradient echo images and transverse T2W fluid-attenuated inversion recovery images were also acquired.

Further diagnostic workup included a CBC, a comprehensive metabolic blood panel (CMP), and measurement of systolic blood pressure (BP). Treatment with phenobarbital administered IV was initiated at a loading dose of 5 mg/kg administered 4 times in the first 24 hours, followed by a maintenance dose of 3 mg/kg administered twice daily pending MRI the following day due to unresponsiveness to treatment with imepitoin.

Diagnostic Test Findings

The MRI images revealed a large solitary well-defined intra-axial lesion affecting the left temporal lobe that was 1 cm wide, causing mild mass effect to the left temporal, parietal, and piriform lobes. The lesion was heterogeneous and composed of a T2W, T2W-FLAIR hypointense halo, and a mostly hyperintense center. In addition, an area of signal void was appreciated on susceptibility-weighted imaging (SWI; **Figure 1; Supplementary Video S2**). The presence of a complete halo on SWI, expected timing of the hemorrhage, rim contrast enhancement, and absence of contrast enhancement without a solid portion were indicative of a 2- to 7-day-old posthemorrhagic intra-axial hematoma. The lesion presented a

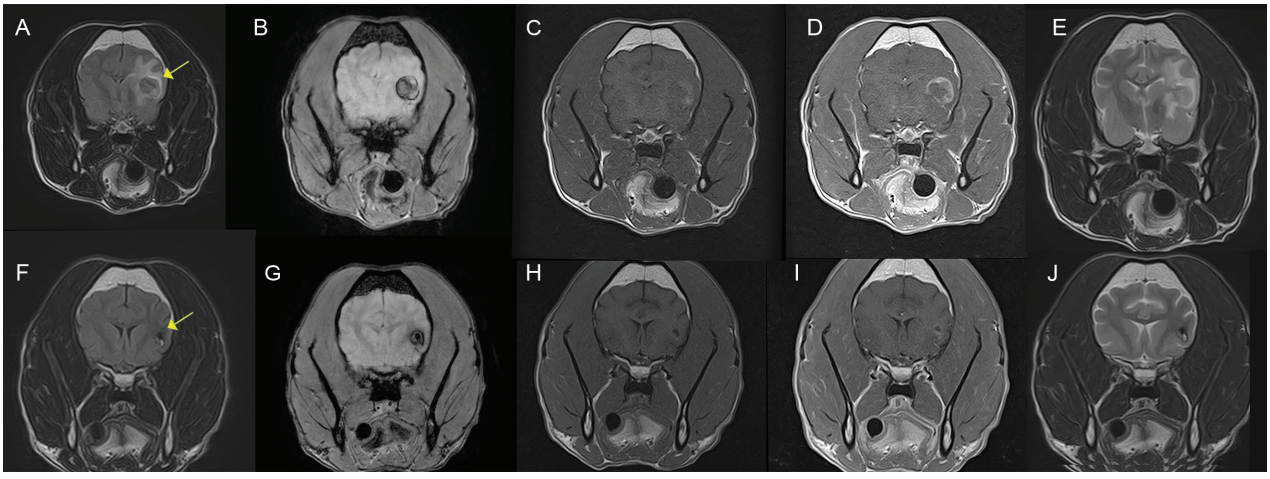

Figure 1—Transverse plane T2-weighted FLAIR (A and F), susceptibility-weighted (B and G), T1-weighted precontrast (C and H), T1-weighted postcontrast (D and I), and T2-weighted (E and J) images. MRI images at the level of the temporal lobes of a 12-year-old sexually intact male Maltese crossbreed dog 3 days (A through E) and 8 weeks (F through J) after sudden-onset cluster seizures. A lesion (arrows) is evident in the left temporal lobe. The dog's left side is toward the right in all images.

clear dichotomous pattern with the center (youngest part) of the lesion corresponding to oxyhemoglobin or intracellular hemoglobin (T2W and SWI hyperintense) and a halo (oldest part) corresponding to extracellular hemoglobin (hyperintense in T1W). All the stated findings were compatible with an early subacute hemorrhage.

The CBC and CMP results revealed no abnormalities. Systolic BP was prehypertensive (145 mm Hg) on admission, according to the 2018 American College of Veterinary Internal Medicine guidelines.[1] Additional tests were performed to search for an underlying cause of the intracranial bleed. These included repeated BP measurements, an abdominal ultrasound, fecal examination (Baerman technique), and coagulation assays (prothrombin, activated partial thromboplastin time, thrombin time, and fibrinogen), all of which were normal or within reference limits. The dog responded well to antiseizure treatment in the first 12 hours, and no new seizures were seen. Progressive neurologic improvement (resolution of cognitive dysfunction and improvement of ataxia) was seen, and the dog was discharged after 3 days of hospitalization with a phenobarbital plasma concentration of 31.8 mg/L (reference range, 15 to 35 mg/L).

The dog was followed up in the coming weeks, and MRI follow-up was performed at 8 weeks. The lesion size was markedly reduced. The lesion was mostly hypointense in T2W, T2W-FLAIR, and T1W and SWI sequences with a small hyperintensity in the center in T2W sequences. The perilesional T2-FLAIR hyperintensity was no longer appreciable. The findings were consistent with chronic hemorrhage and confirmed partial resolution of the lesion (Figure 1) and perilesional edema.

Comments

Stroke, or cerebrovascular accident, is the leading cause of seizures and late-onset epilepsy in humans over 60 years old. Its frequency of occurrence in veterinary medicine is unclear and suspected to constitute up to 2% of neurologic cases at referral institutions.[2] Stroke can be ischemic (occlusion of a cerebral blood vessel leading to reduction of perfusion of affected brain tissue) or hemorrhagic (rupture of a cerebral blood vessel followed by bleeding in or around the brain). Nontraumatic intracranial hemorrhage leading to intraparenchymal hematoma may have various underlying etiologies in dogs. Secondary causes include neoplasia (such as hemangiosarcoma, meningioma, lymphoma, and adenoma in case of pituitary apoplexy[3]), infection with *Angiostrongylus vasorum*, chronic kidney disease, and hypothyroidism.[4] Spontaneous cerebral bleeds may occur due to hypertension or ceroid amyloid angiopathy.[4] However, in many dogs, no underlying cause of the hematoma is found, warranting symptomatic treatment. In a recent study[5] of 10 dogs with intraparenchymal hematomas, seizures were reported in 4 dogs and no underlying cause for the hematomas was found in 90% of the cases.

Intraparenchymal brain hematomas have characteristic appearance on MRI images due to the paramagnetic properties of blood breakdown products (hemoglobin being broken down into hemosiderin and ferritin). They usually appear as well-marginated lesions with a central area and distinct peripheral rim, often with various signal intensity.[5] This characteristic appearance is caused by a more rapid blood breakdown in the center of the hematoma rather than peripherally. The characteristic T1W and T2W signal intensities at different stages of a hemorrhage allow for its detection and age, although pulse sequence gradient echo and SWI allow more sensitive and specific visualization of intracranial bleeding, also allowing good imaging of vessel structure.[6]

In humans, ischemic or hemorrhagic stroke extensiveness, the presence of hemorrhagic stroke (both subarachnoid and intracerebral), and cortical stroke are the 3 most important predictive factors for epileptogenesis. Others, such as cortical damage, hippocampal involvement, and multifocal stroke sites may complicate prognosis. Poststroke seizures (PSSs) occur following a stroke without previous history of epilepsy. They can be early (within 7 days following stroke) or late onset (occurring at least 7 days poststroke). Early-onset seizures are induced as a result of the pathological changes caused by the stroke itself, while late-onset seizures are truly epileptic as a result of chronic brain injury and its resulting neuronal hyperexcitability. If the seizures recur, epilepsy (poststroke epilepsy) is diagnosed and may require long-term treatment with antiseizure medication. Prognosis for intraparenchymal hemorrhagic stroke is dependent on the extent of the lesion (or lesions, if multiple) and its underlying cause. In dogs with a single primary brain hemorrhage, the prognosis has been reported to vary from good to excellent.[4]

The dog of the current study most likely suffered from early-onset PSS but was treated long-term with antiseizure medication. Follow-up at 2, 6, and 12 months revealed no new seizures and no neurologic deficits with a stable phenobarbital serum concentration (24.08 mg/L measured at 12 months following initial presentation; reference range, 15 to 35 mg/L). Tapering of the antiseizure medication could have been attempted but was not undertaken due to the dog suffering no medication side effects.

Although PSSs remain an infrequent diagnosis in geriatric canine veterinary patients presenting with seizures, they should be considered in the differential diagnosis. When imaging intra-axial lesions, special sequences should be added to the scanning protocol to facilitate diagnosis of bleeding. The latest literature suggests SWI or T2* sequences for this. Follow-up imaging of the lesion is helpful in supporting the initial neurologic diagnosis and nature of the cerebral hemorrhage and allows monitoring of the lesion resolution.

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Supplementary Materials

Supplementary materials are posted online at the journal website: avmajournals.avma.org