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Case Report Rapport de cas

Computed tomography findings in a 5-year-old Australian Cashmere goat *(Capra hircus)* suffering leukoencephalomyelitis due to caprine arthritis encephalitis virus

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Abstract — Computed tomography was used to aid in the antemortem diagnosis of leukoencephalomyelitis in a goat infected by caprine arthritis encephalitis virus (CAEV). Imaging results were corroborated by histologic examination. This report discusses various methods of imaging the nervous system and their potential for use in the antemortem diagnosis of CAEV neurologic changes.

Résumé — Résultats d'une tomodensitométrie chez une chèvre cachemire de l'Australie *(Capra hircus)* âgée de 5 ans souffrant d'une lymphoencéphalomyélite en raison du virus de l'arthrite caprine. La tomodensitométrie a été utilisée pour faciliter le diagnostic antemortem de la lymphoencéphalomyélite chez une chèvre infectée par le virus de l'arthrite-encéphalite caprine (VAE). Les résultats de l'imagerie ont été corroborés par l'examen histologique. Ce rapport discute les diverses méthodes d'imagerie du système nerveux et leur utilisation potentielle pour le diagnostic antemortem des changements neurologiques du VAE.

(Traduit par Isabelle Vallières)

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This report is the first describing the use of computed tomography (CT) as an aid in the diagnosis of caprine arthritis encephalitis virus (CAEV)-induced leukoencephalomyelitis in a goat. Computed tomography was successful in identifying multifocal cerebral and cerebellar disease and imaging results concurred with histologic findings. It is likely that the goat reported here suffered from advanced neurologic changes associated with CAEV. It is unknown if CT imaging would be able to detect earlier, more subtle neurologic lesions of CAEV.

Case description

A 5-year-old, 34.5-kg, intact, female goat *(Capra hircus)* was presented with a 3-week history of progressive lethargy, separation from the herd, weakness, and difficulty prehending feed. Relevant history included a witnessed incidence of head-butting with a herdmate 3 d prior to the onset of clinical signs. While CAEV was diagnosed previously within the herd, clinical signs were rarely observed. The CAEV serological status of the goat reported here was unknown at the time of presentation.

Physical examination revealed bilateral, decreased menace response; unilateral (OD) absent palpebral reflex; and flaccid paralysis of the right side of the face. Bilateral corneal and direct and consensual pupillary light responses (PLR) were normal. Decreased menace with normal PLR was consistent with a cortical lesion. Concurrent decreased menace and palpebral reflexes (unilateral) could also suggest a unilateral lesion of the facial nerve or orbicularis oculi muscle. The observed right-sided facial paralysis made a lesion involving the right facial nerve most likely. While ambulating the goat appeared ataxic and leaned to the left. Decreased proprioception was also observed, more notable on the left side. When considering the cranial nerve findings, the goat's proprioceptive deficits and ataxia were deemed to be cortical in origin. Furthermore, the goat was considered cortically blind based on bilaterally absent menance responses, normal PLR, disorientation, and inability to navigate in her surroundings. Pulmonary auscultation revealed normal lung fields and respiratory rate. The goat was slightly hypothermic [rectal temperature 38.5°C; reference interval (RI): 38.6°C to 40°C] and tachycardic (104 beats/min; RI: 70 to 90 beats/min) (1). There was 1 weak rumen contaction per minute.

Complete blood cell count revealed mild neutrophilia (8658 cells/μL; RI: 1200 to 7200 cells/μL), monocytosis (702 cells/μL; RI: 0 to 600 cells/μL), and hyperfibrinogenemia (5 g/L; RI: 1 to 4 g/L). There were no cellular abnormalities.

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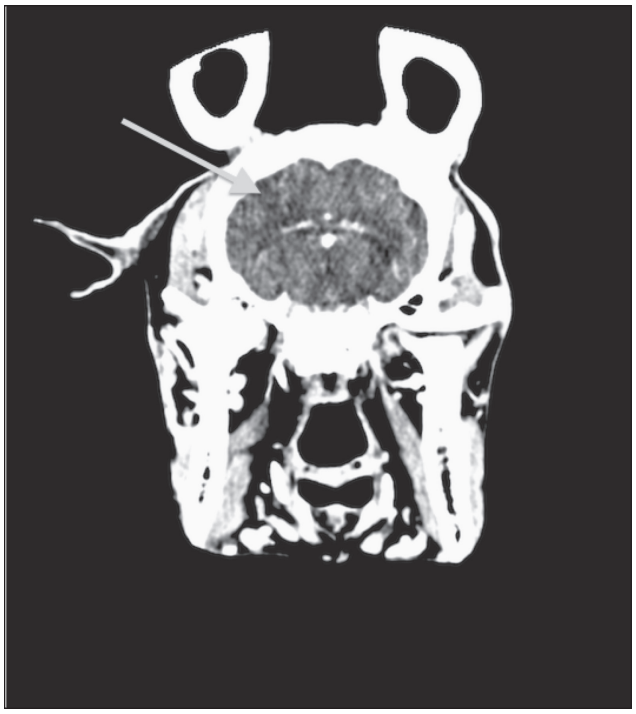

Figure 1. Transverse computed tomographic image in a brain window. The cerebral cortex is mottled in attenuation with a poorly defined hypoattenuating region dorsolateral to the left lateral ventricle (arrow). The region is located within the cortical grey matter adjacent to the internal capsule and corona radiata.

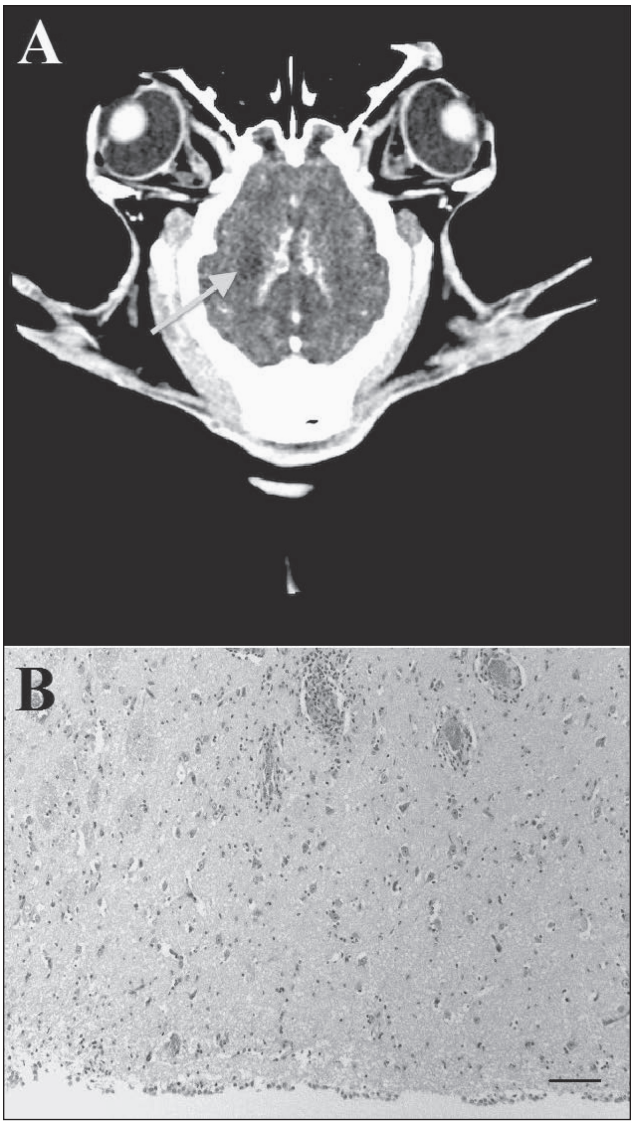

Figure 2. Panel A – Dorsal reconstruction computed tomographic image in a brain window. This reconstruction also depicts the hypoattenuating area described in Figure 1 (arrow). B – Low magnification image of the cerebrum at the level of the left lateral ventricle (at bottom) illustrating gliosis, perivascular cuffs of mononuclear inflammatory cells, and hemorrhage. Bar = 100 μm

Abnormal findings on serum biochemistry included mildly elevated creatine kinase (329 U/L; RI: 35 to 185 U/L) which was likely related to mild trauma or recumbency. Cerebral spinal fluid (CSF) collected from the lumbosacral space was unremarkable on cytological analysis. Level of lead in the blood was within the reference range (0.14 μmol/L; reference value: < 0.48 μmol/L). Capture enzyme-linked immunosorbent assay (c-ELISA) performed on blood serum indicated a positive antibody titer for CAEV.

The goat was administered flunixin meglumine (Prevail; MWI Veterinary Supply, Meridian, Idaho, USA), 1.1 mg/kg body weight (BW), SQ, as an anti-inflammatory agent once every 24 h. A single dose of thiamine hydrochloride (VEDCO Incorporated, St. Joseph, Missouri, USA), 30 mg/kg BW, SQ, was administered to address potential thiamine-responsive polioencephalomalacia and for anti-oxidant effects. A single dose of dexamethasone sodium phosphate (MWI Veterinary Supply) 0.5 mg/kg BW, IV, was administered on day 2 of hospitalization for anti-inflammatory effects. In light of the goat's debilitated state, mild signs of inflammation, and likely CNS involvement, Florfenicol (Nuflor; Schering-Plough Animal Health, Union, New Jersey, USA), 25 mg/kg BW, SQ, q24h, was provided for broad-spectrum antimicrobial activity and CNS penetration.

Based on clinical signs, a cortical lesion and unilateral, central facial nerve involvement were suspected. Because of the lack of response to support and therapy, and the likelihood of an intracranial lesion, imaging via computed tomography (CT) was elected, because it could aid in identifying mass lesions such as neoplasia or abscess and help rule out hemorrhage associated with skull trauma. A 14 G, intravenous jugular catheter (Abbocath; Abbot Laboratories, North Chicago, Illinois, USA) was aseptically placed and the goat was sedated with xylazine (AnaSed; LLOYD Incorporated, Shenandoah, Iowa, USA), 0.4 mg/kg BW, IV. The goat was positioned in sternal recumbency and transverse CT images (3 mm slices) of the head were obtained pre- and post-intravenous administration of ioxilan iodinated contrast (Oxilan; Guerbet LLC, Bloomington, Indiana, USA), 100 cc bolus IV, using a 16-slice helical CT scanner. On the CT images, the cerebrum and cerebellum had a diffusely mottled pattern of attenuation with multiple, poorly defined areas of hypo-attenuation, best visualized with a brain window (Figures 1 and 2). A better defined focal area of contrast enhancement was identified in the rostral cerebellum (Figure 3). Soft tissue hypo-attenuating, non-contrast enhancing material

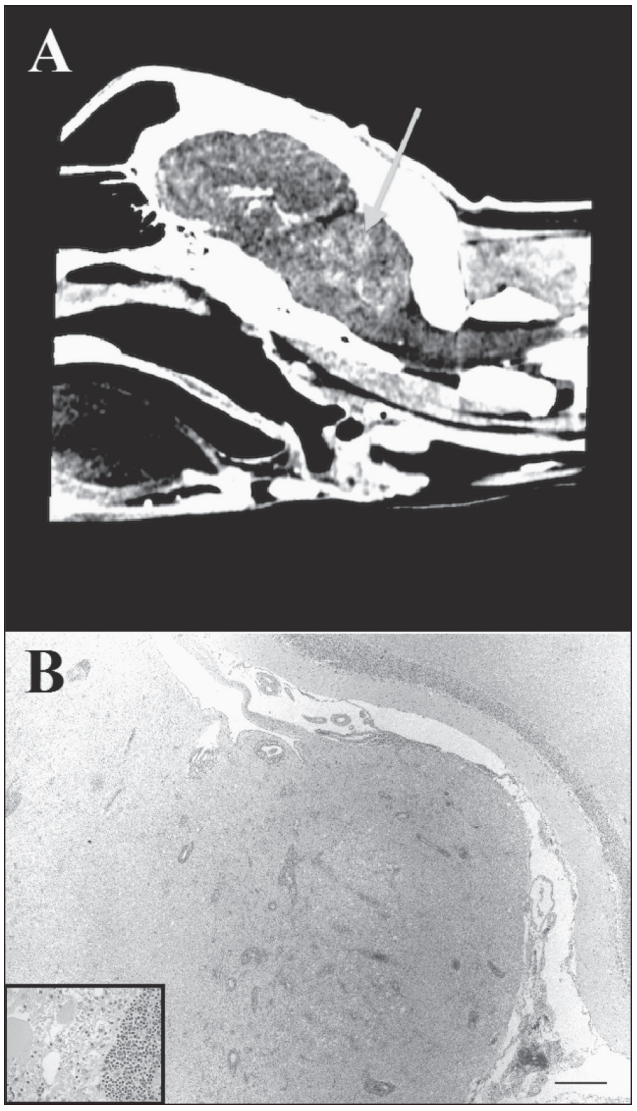

Figure 3. Panel A – Sagittal reconstruction computed tomographic image in a brain window. An area of contrast enhancement is present in the rostral cerebellum (arrow). Panel B – Low magnification of the cerebellum and brain stem illustrating rarefaction, gliosis, and infiltration of the neuropil and choroid plexus by numerous mononuclear cells. Inset: High magnification illustrating the inflammatory infiltrate is composed predominately of lymphocytes, plasma cells, and histiocytes. Bar = 500 μm

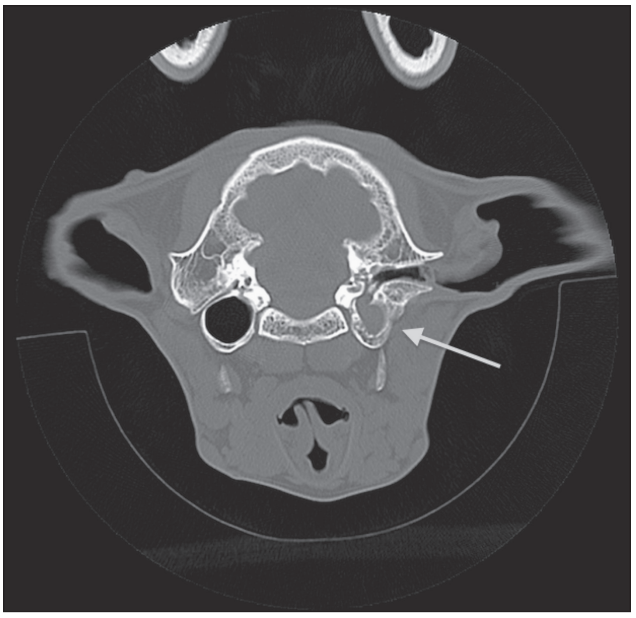

Figure 4. Transverse computed tomographic image in a bone window. The right tympanic cavity is filled with soft tissue attenuation and the right typanic bulla is thickened (arrow).

and/or fluid was also present in the right tympanic cavity which had a thickened right tympanic bulla (Figure 4). Cortical and cerebellar findings were consistent with diffuse inflammatory disease, whereas the right otitis media was considered an incidental finding.

Despite support and treatment, the goat's clinical condition deteriorated. On day 7, euthanasia was elected due to the poor prognosis. On gross postmortem examination, no abnormalities involving the central nervous system were observed.

Histologic examination of sampled regions of the brain revealed marked inflammation, gliosis, and a large area of rarefaction of the white matter in the region of the right brainstem beginning at the level of the rostral colliculus and extending caudally to the obex. In the most severely affected periventricular areas, cavitation of the white matter was observed. Numerous gitter cells, gemistocytic astrocytes, lymphocytes, and plasma cells infiltrated the areas of rarefaction. Virchow-Robin's spaces were moderately to severely expanded by abundant lymphocytes, plasma cells, and fewer histiocytes. Similar, less severe lesions corresponding to areas revealed in the CT scan were seen in the cerebellum and cerebrum. Small numbers of lymphocytes, plasma cells, and histiocytes were scattered throughout the meninges. Widely scattered, small foci were mineralized within the degenerate regions. The adjacent choroid plexus was expanded by few lymphocytes, plasma cells, and histiocytes. Replicate sections stained with Brown and Hopp's Gram stain failed to reveal any bacteria. Immunohistochemistry of a section of brainstem was positive for CAEV. Lentiviral leukoencephalomyelitis was considered the most likely cause of the goat's neurological signs.

Discussion

Caprine arthritis and encephalatis virus (CAEV) is included in the group of small ruminant lentiviruses (SRLVs) that include ovine progressive pneumonia virus (OPPV), and visna maedi virus (VISNA) (1). Leukoencephalomyelitis in young goat kids was first reported in 1974 (2). In 1980, CAEV was isolated and determined to be the etiologic agent of leukoencephalomyelitis in young kids as well as arthritis in adult goats (3). Subsequent to these reports, CAEV and OPPV were also found to be associated with lymphoproliferative mastitis in goats and sheep, respectively (4,5). The seroprevalence of CAEV in the US, Canada, and Europe is reported to range between 38% to 81% of goat herds (6–8).

Infection by CAEV occurs largely via transmission of fluids containing infected macrophages from infected to non-infected animals. Efficient means include the transmission of virus in

colostrum and milk between does and kids and between lactating does (9). Lung tissue from seropositive goats may contain infectious CAEV suggesting that respiratory secretions may also contribute to horizontal transmisison; however, there are no reports demonstrating shedding of CAEV in oronasal secretions.

Clinical syndromes described for CAEV-infected goats include arthritis, interstitial pneumonia, mastitis, leukoencephalomyelitis, and a wasting disorder characterized by poor body condition and rough hair coat. Clinical disease may only be observed in approximately 10% of goats from a CAEV-infected herd, and up to 85% of seropositive goats may be clinically normal (10). While the neurologic manifestation of CAEV is typically observed in kids from 1 to 4 months of age, it is occasionally seen in adults (11).

Diagnosis of CAEV is based on clinical signs combined with serologic or molecular tests (12). The most commonly used serologic testing methods include agar gel immunodiffusion (AGID) and various ELISAs. To optimize test sensitivity and specificity, it is important that the strain of CAEV from the suspected animal coincides with the strain of virus used in the diagnostic test (12). In the case reported here, CAEV was suspected as the cause of the goat's neurologic condition based on cELISA test results.

Irrespective of the clinical syndrome that is manifest, clinical signs of CAEV are largely non-specific (e.g., lameness, neurolgic deficits). In the case of neurologic disease, ancillary testing methods such as CSF analysis can also be used. Typically, CSF fluid from goats suffering leukoencephalomyelitis has elevated protein levels and mononuclear pleocytosis. However, the sensitivity of CSF evaluation is unclear and in the case reported here, there were no remarkable changes reported upon CSF analysis. Until recently, a sensitive, practical, non-invasive, antemortem diagnostic test for CAEV-induced neurologic disease had not been available.

A combininations of clinical examination findings, serologic testing results, and diagnostic imaging techniques has potential to aid in the localization, characterization, and diagnosis of CAEV-induced neurologic disease. The goat in this report was obtunded, disoriented, and displayed neurologic signs including cranial nerve deficits and ataxia. In light of the goat's clinical status, avoiding potential risks associated with general anesthesia was preferred. Instead, CT examination of the brain was performed under moderate sedation, from which the goat recovered uneventfully.

Several modalities have been used for brain imaging including CT, magnetic resonance imaging (MRI), and positron emmission tomography (PET). In general, MRI is preferred over CT for examination of the brain due to its superior soft tissue detail and contrast. However, in veterinary patients, MRI of the brain requires the use of general anesthesia to avoid complication from motion artifacts. Furthermore, the cost and length of the MRI examination are generally greater than that of CT. Positron emission tomography is a valuable tool for the detection of neuroinflammation in the brain (13). Experimental studies using PET have been used to image macrophages in animal models of lentiviral-induced neurologic disease (14), but PET is not widely available and is significantly more costly than CT. In comparison to MRI and PET imaging, CT is more widely available, more rapid, and less costly, which is why it was chosen in this case. Despite the limitations of CT in soft tissue imaging, it has been used as a diagnostic tool in numerous cases of suspected brain disease in veterinary (15,16) and human (17) patients. Furthermore, CT has been successfully used in experimental studies of SRLV lung disease in sheep (18).

Although there is a lack of studies using CT for imaging of the caprine brain, CT has been used in the diagnosis of inflammatory brain disease in other species. In dogs and cats with encephalitis, CT features include ventricular asymmetry, facial deviation or multifocal changes in attenuation, and primarily hypodense regions within the parenchyma (16). The changes in brain parenchymal attenuation may or may not be contrast-enhancing, as in this case. If the lesions are contrast-enhancing, the enhancement has been reported to either be uniform or rim-enhancing, making differentiation from neoplasia difficult (15,16). In comparison to solitary mass lesions, multifocal inflammatory lesions can be difficult to identify on CT, especially in equine patients due to the dense petrous portion of the temporal bones causing beam-hardening artifacts and the size of the horse head (19,20). The relatively low sensitivity of CT in identifying inflammatory or infectious brain disease suggests that a normal CT examination does not rule out these disease processes. While the CT changes reported in this goat were not likely to be specific for CAEV, they corroborated both clinical and serologic findings and helped rule out other types of brain pathology. CVJ

References

1. Smith MC, Sherman DM. Fundamentals of goat practice. In: Smith MC, Sherman DM, eds. Goat Medicine. Ames, Iowa: Blackwell Publishing, 2007:3–22.
2. Cork LC, Hadlow WJ, Crawford TB, Gorhanm JR, Piper RC. Infectious leukoencephalomyelitis of young goats. J Infect Dis 1974;129:134–141.
3. Crawford TB, Adams DS, Cheever WP, Cork LC. Chronic arthritis in goats caused by a retrovirus. Science 1980;207:997–999.
4. Kennedy-Stoskopf S, Narayan O, Strandberg JD. The mammary gland as target organ for infection with caprine arthritis-encephalitis virus. J Comp Pathol 1985;95:609–617.
5. Cutlip RC, Lehmkuhl HD, Brogden KA, Bolin SR. Mastitis associated with ovine progressive pneumonial virus in sheep. Am J Vet Res 1985;46:326–328.
6. Crawford TB, Adams DS. Caprine arthritis-encephalitis: Clinical features and presence of antibody in selected goat populations. J Am Vet Med Assoc 1981;178:713.
7. Rowe JE, East NE, Franti CE, Thurmond MC, Pedersen NC, Theilen GH. Risk factors associated with the incidence of seroconversion to caprine arthritis-encephalitis virus in goats on California dairies. Am J Vet Res 1992;44:2396.
8. East NE, Rowe JD, Madewell BR, Floyd K. Serologic pervalence of caprine arthritis encephalitis virus in California goat dairies. J Am Vet Med Assoc 1987;190:182.
9. Rolland M, Mooney J, Valas S, Perrin G, Mamoun RZ. Characterization of an Irish caprine lentivirus strain-SRLV phylogeny revisited. Virus Res 2002;85:29–39.
10. Cebra C, Cebra M. Diseases of the hematologic, immunologic, and lymphatic systems (multisystem disease). In: Pugh DG, ed. Sheep and Goat Medicine. Philadelphia, Pennsylvania: WB Saunders, 2002:359–391.
11. Machen MR, Waldridge BM, Cebra C, et al. Diseases of the neurologic system. In: Pugh DG, ed. Sheep and Goat Medicine. Philadelphia, Pennsylvania: WB Saunders, 2002:277–316.
12. Hermann-Hoesing LM. Diagnostic assays used to control small ruminant lentiviruses. J Vet Diag Invest 2010;22:843–855.
13. Kannan S, Balakrishnan B, Muzik O, Romero R, Chugani D. Positron emission tomography imaging of neuroinflammation. J Child Neurol 2009;24:1190–1199.

14. Venneti S, Lopresti BJ, Wang G, et al. PET imaging of brain macrophages using the peripheral benzodiazepine receptor in a macaque model of neuroAIDS. J Clin Invest 2004;113:891–899.
15. Heckt S. Brain. In: Schwartz T, Saunders J, eds. Veterinary Computed Tomography. Ames, Iowa: Wiley-Blackwell, 2011:185–195.
16. Plummer SB, Wheeler, SJ, Thrall DE, Kornegay JN. Computed tomography of primary inflammatory brain disorders in dogs and cats. Vet Radiol Ultrasound 1992;33:307–312.
17. Kastrup O, Wanke I, Maschke M. Neuroimaging of infections. NeuroRx 2005;2:324–332.
18. Cadore JL, Loubeyre P, Vuillermoz S, Ciyrt-Fortune I, Revel D, Mornex JF. Early diagnosis of lentivirus-induced infiltrative lung disease in sheep by high resolution computed tomography. Eur Respir J 1997;10:1456–1459.
19. Lacombe VA, Sogaro-Robinson C, Reed SM. Diagnostic utility of computed tomography imaging in equine intracranial conditions. Equine Vet J 2010;242:393–399.
20. Kinns J, Tucker R. Equine calvarium, brain and pituitary gland. In: Schwartz T, Saunders J, eds. Veterinary Computed Tomography. Ames, Iowa: Wiley-Blackwell, 2011:443–449.

Answers to Quiz Corner
Les réponses du test éclair

1. **a)** It is important to isolate and specifically clamp and ligate the bleeding vessel. The ureter is located in this area and gross ligation could occlude the ureter.
a) Il est important d'isoler, d'écraser et de ligaturer spécifiquement le vaisseau qui saigne. L'uretère est situé dans cette région et une ligature peut l'étrangler.

2. **c)** Suture material in the bladder lumen can serve as a nidus for formation of cystic calculi.
c) Les sutures qui atteignent la lumière de la vessie peuvent servir de nid pour la formation de calculs vésicaux.

3. **c)** All cats with clinical panleukopenia have leukopenia in the early acute phase.
c) Tous les chats qui manifestent une panleucopénie clinique montrent une leucopénie dans la phase aiguë de la maladie.

4. **c)** Household bleach is highly effective against parvovirus.
c) L'eau de Javel est hautement efficace contre le parvovirus.

5. **b)** Exuberant granulation tissue is very common in horses with distal limb lacerations.
b) Le tissu de granulation exubérant est très commun chez les chevaux souffrant de lacérations distales des membres.

6. **a)** The cause is not determined in most cases of laryngeal hemiplegia.
a) La cause n'est pas déterminée dans la plupart des cas d'hémiplégie laryngée.

7. **d)** Torsion of the mesenteric root results in volvulus of the small and large intestine. It is rapidly fatal, with affected cattle or other ruminants succumbing in 2 to 4 hours. The other conditions listed cause death if left untreated; however, affected cattle usually survive at least 24 hours and sometimes several days after onset of each of these conditions.
d) La torsion de la racine du mésentère produit le volvulus du petit et du gros intestin. Elle est rapidement mortelle; les bovins et les autres ruminants atteints meurent après 2 à 4 heures. Les autres problèmes énumérés causent la mort s'ils ne sont pas traités. Cependant, les bovins affectés survivent habituellement au moins 24 heures et quelquefois plusieurs jours après l'apparition de chacun des problèmes.

8. **e)** Lymphosarcoma can cause abomasal ulcers, but usually in older cows.
e) Le lymphosarcome peut causer des ulcères de la caillette, mais ils se trouvent habituellement chez les vaches âgées.

9. **d)** Several studies have documented that selenium deficiency in the sow predisposes piglets to iron toxicosis.
d) Plusieurs études ont démontré qu'une carence en sélénium chez la truie prédispose les porcelets à la toxicose par le fer.

10. **a)** Amylase is a pancreatic enzyme. All the other values may be affected by the necrotic and cytotoxic effects of Crotalidae venoms.
a) L'amylase est une enzyme pancréatique. Toutes les autres valeurs peuvent être affectées par les effets nécrotiques et cytotoxiques du venin des Crotalidés.