# Perianesthetic complications in dogs undergoing magnetic resonance imaging of the brain for suspected intracranial disease

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**Objective**—To evaluate the occurrence of perianesthetic complications in dogs undergoing MRI for suspected intracranial disease and identify risk factors associated with observed complications.

**Design**—Retrospective case-control study.

**Animals**—238 client-owned dogs undergoing MRI of the brain.

**Procedures**—Signalment, clinical signs, neurologic examination findings, presumptive diagnosis, anesthesia-related variables, whether CSF was collected and CSF analysis results, severe perianesthetic complications (need for a ventilator following anesthesia or perianesthetic death), and anesthetic recovery time were recorded. Selected factors were compared between dogs with and without intracranial lesions and dogs with and without perianesthetic complications (including severe complications and prolonged anesthetic recovery [> 20 minutes from the end of anesthesia to extubation]).

**Results**—3 of 149 (2%) dogs with and 0 of 89 dogs without intracranial lesions required ventilation following anesthesia; the difference was nonsignificant. Recovery time was significantly longer in dogs with (median, 15 minutes) than in dogs without (10 minutes) intracranial lesions. Abnormal mentation prior to anesthesia was the only clinical sign that differed significantly between dogs with (15/26 [58%]) and without (70/212 [33%]) perianesthetic complications. A significantly larger proportion of dogs with perianesthetic complications had intracranial masses (13/26 [50%]), compared with dogs without these complications (56/212 [26%]).

**Conclusions and Clinical Relevance**—Dogs with complications were more likely to have had intracranial lesions than were dogs without complications, but few dogs had severe complications. Abnormal mentation was more common in dogs with than in dogs without complications. Prospective studies to further evaluate perianesthetic risk factors and procedures for improving outcomes in these patients are warranted. (*J Am Vet Med Assoc* 2013;243:1310–1315)

Diagnosing the cause of intracranial disease is a common challenge in small animal medicine. Generally, advanced imaging, CSF analysis, or both are required to establish a diagnosis, and these procedures require general anesthesia. The most commonly recommended advanced imaging modality is MRI, which often necessitates anesthesia for up to 2 hours.

General anesthesia carries a risk of perianesthetic complications and even anesthetic-related death in animals, and animals with intracranial disease are generally considered to be at an increased risk of these complications. Associations between general anesthesia and complications or death in dogs have been investigated in patient populations in private practice and university teaching hospitals.[1–4] Anesthetic complications are common and have been reported to occur in 12% to 63% of dogs under general anesthesia.[3,4] The most common anesthetic complications reported include hypoventilation, hypotension, bradycardia, and hypothermia.[3,4] Perianesthetic death has been reported to occur in 0.1% to 0.94%[1–4] of dogs under general anesthesia. Factors associated with an increased risk of perianesthetic death include increased patient age, increased American Society of Anesthesiologists physical status, increased urgency or intended duration of the procedure, body weight < 5 kg (11 lb), and the use of inhalation anesthetics alone.[2]

The use of general anesthesia in dogs with intracranial disease undergoing MRI introduces additional challenges and risks.[5] To minimize the risk of anesthetic complications, the patient must be at an appropriate plane of anesthesia to allow completion of the MRI procedure while maintaining normal homeostasis. One of the most crucial aspects of normal homeostasis is maintaining adequate

**Abbreviations**

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| CBF | Cerebral blood flow |
| FLAIR | Fluid-attenuated inversion recovery |
| ICP | Intracranial pressure |

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CBF. Although normally maintained by autoregulatory mechanisms that respond to changes in partial pressure of arterial $CO_2$, CBF is affected by changes in arterial oxygenation, mean arterial blood pressure, and venous outflow. The autoregulatory mechanisms maintaining CBF can be influenced by anesthetic techniques and common anesthetic complications, such as hypoventilation and hypotension, which have detrimental effects on CBF in patients with intracranial disease. Because of limited compliance of the cranial vault, increased CBF can translate into an increase in ICP. In patients that may already have relatively high ICP, small increases in CBF can cause dangerous increases in ICP. Decreases in CBF can decrease ICP but also lead to cerebral ischemia. Thus, any alteration in CBF can potentially worsen neurologic function in animals with intracranial disease, leading to serious perianesthetic complications.[5] Treatment with osmotic diuretics, such as mannitol or hypertonic saline solution, to reduce cerebral edema and improve CBF and avoiding use of certain anesthetics such as nitrous oxide, which may increase ICP due to cerebral vasodilation, and ketamine, which may increase ICP and cerebral metabolic rate, may mitigate the risk of anesthetic-related complications in these patients.[5] Avoidance of hyper- or hypocapnia and the resultant increase or decrease of ICP, respectively, and prevention of hypotension, which reduces CBF, are important during anesthesia.[5–7]

Although these principles are well understood, perianesthetic complications and death in dogs undergoing general anesthesia for MRI of the brain have not been previously reported. The objectives of the study reported here were to evaluate the occurrence of perianesthetic complications in dogs undergoing MRI for suspected intracranial disease and to identify risk factors for the observed complications. We hypothesized that dogs with intracranial lesions would be more likely to develop perianesthetic complications, compared with dogs without intracranial lesions.

## Materials and Methods

**Selection of cases and controls**—Electronic medical records at the University of Minnesota Veterinary Medical Center from January 1, 2010, to December 31, 2011, were reviewed to identify dogs that underwent general anesthesia for MRI of the brain. Dogs were included in the study if they were client-owned animals, if no invasive procedure other than collection of CSF was performed during the same anesthetic event as the MRI, and if a physical and neurologic examination was performed by a University of Minnesota Veterinary Medical Center clinician prior to anesthesia and MRI. Dogs without anesthetic records or with incomplete anesthetic records were included when perianesthetic outcome could be determined from the remaining medical record. Only the initial anesthetic episode for brain MRI was considered for any dog. Initially, dogs diagnosed as having intracranial lesions were classified as case animals and those without intracranial lesions were classified as controls; these dogs were later regrouped on the basis of presence or absence of perianesthetic complications for further investigations.

**Procedures**—All dogs were evaluated with 3-T MRI equipment, and the images were reviewed by a board-certified veterinary radiologist at the facility where the study was performed. T2-weighted (transverse, sagittal, and dorsal planes), T2-weighted FLAIR (transverse plane), T2-weighted gradient echo (transverse plane), T1-weighted FLAIR (transverse plane), diffusion-weighted (with mean diffusion coefficient and fractional anisotropy maps; dorsal plane), diffusion tensor, 3-D time-of-flight, T1-weighted contrast-enhanced FLAIR (transverse plane), and T1-weighted contrast-enhanced (sagittal and dorsal plane) images were evaluated, and multivoxel spectroscopy was performed for all MRI examinations. Cisternal CSF samples were collected when deemed necessary by the attending clinician and were evaluated for protein content as well as type, count, and morphology of cells by a board-certified veterinary clinical pathologist at the study facility.

Signalment, clinical signs, neurologic examination findings, presumptive diagnosis, whether CSF was collected, and results of CSF analysis were recorded. The presence of specific neurologic signs (including abnormal mentation; abnormalities of posture or gait; proprioception, spinal reflex, cranial nerve, or optic tract deficits; and evidence of spinal pain) was determined on the basis of results of the neurologic examination; episodic neurologic abnormalities such as seizures were determined from historical information provided by owners. For dogs with intracranial lesions, histopathologic diagnosis was not typically available but was substituted for presumptive diagnosis when possible.

Dogs were classified as having intracranial lesions if lesions were identified within the brain by use of MRI and were judged to be clinically relevant or if results of CSF analysis were consistent with inflammatory CNS disease. This group included dogs with presumptive diagnoses of inflammatory CNS disease, hydrocephalus, infarction (stroke), single or multiple masses, brain trauma or hemorrhage, degenerative CNS disease, hepatic encephalopathy,[8–11] cerebellar herniation, or an open diagnosis with unclassified lesions present. Dogs with occipital malformations and associated syringomyelia were also considered to have intracranial lesions.

Dogs without intracranial lesions included those that had no clinically relevant brain lesions identified via MRI and no evidence of inflammatory CNS disease determined by analysis of CSF. This group included dogs with the diagnoses of normal brain, idiopathic epilepsy, peripheral neuropathy, idiopathic vestibular disease, middle ear disease, ophthalmic disease, idiopathic tremor, and masticatory muscle myositis. Dogs with minor lesions considered incidental and unrelated to the current clinical signs on the basis of neuroanatomical localization (eg, evidence of previous infarction, mild breed-related hydrocephalus, or lesions thought to be anatomic variation) were included in this group as having an open diagnosis, along with dogs with no identifiable lesions but apparent neurologic signs. One dog with an occipital malformation but no associated cerebellar herniation or syringomyelia was also included in this group.

The occurrence of hypotension (mean arterial blood pressure < 60 mm Hg [or systolic arterial blood pressure < 90 mm Hg if mean arterial blood pressure was not available]), hypocapnia (end-tidal $CO_2$ < 30 mm Hg), hypercapnia (end-tidal $CO_2$ > 40 mm Hg),

and severe perianesthetic complications (death [including euthanasia] or need for a ventilator following anesthesia) were recorded in addition to time to extubation from the end of anesthesia. The perianesthetic period was defined as the time from premedication until extubation. When extubation time was not documented, evaluation for the presence of spontaneous breathing prior to the end of the anesthetic record was recorded if available. The end of anesthesia was defined as the time that inhalation anesthesia was discontinued. Anesthetic drug protocols and any drugs given to decrease ICP or edema (including mannitol, furosemide, and dexamethasone sodium phosphate) or to reverse an anesthetic agent in the perianesthetic period were also recorded. Dogs were classified as having prolonged recovery from anesthesia after the MRI procedure if > 20 minutes elapsed from the end of anesthesia to extubation. This cutoff was established on the basis of professional opinions of clinicians in the University of Minnesota Veterinary Medical Center's anesthesia and neurology service groups.

**Statistical analysis—**Occurrence of severe perianesthetic complications and time to extubation after anesthesia were compared between dogs with and without intracranial lesions. Other variables compared between groups included breed, age, sex, weight, clinical signs, and whether a CSF sample was collected. In addition to the same signalment factors and clinical signs, presumptive diagnosis and anesthetic variables including drug administration, whether a ventilator was used during anesthesia, whether nitrous oxide was administered as part of the anesthetic protocol, and occurrence of hypotension, hypocapnia, or hypercapnia were compared between dogs categorized as having severe perianesthetic complications or prolonged anesthetic recovery and dogs that did not develop these complications.

A Fisher exact test was used for comparisons of categorical data (ie, sex [male vs female, including neuter status]; breed; whether a CSF sample was collected; presence of specific clinical signs; presumptive diagnosis; presence of hypotension, hypocapnia, or hypercapnia; occurrence of severe perianesthetic complications or prolonged recovery time; whether a ventilator was used during anesthesia; and whether a specific drug was part of the anesthetic protocol) between groups. Mann-Whitney nonparametric testing was used to evaluate continuous data such as weight, age, and time to extubation. Values of $P < 0.05$ were considered significant. Commercially available statistical software[a] was used for all calculations.

## Results

Records review identified 238 dogs that met study inclusion criteria; 149 (73 neutered females, 8 sexually intact females, 61 neutered males, and 7 sexually intact males) were categorized as having intracranial lesions and 89 (40 neutered females, 4 sexually intact females, 38 neutered males, and 7 sexually intact males) were categorized as having no intracranial lesions. Breeds included Labrador Retriever (n = 25); Golden Retriever (17); German Shepherd Dog (12); Boxer (11); Yorkshire Terrier (9); Shetland Sheepdog (7); Pug (7); French Bulldog (6); Cavalier King Charles Spaniel (6); Siberian Husky (5); Cocker Spaniel, Shih Tzu, Australian Shepherd, Chihuahua, Dachshund, Airedale, Miniature Schnauzer, and Greyhound (4 each); and ≤ 3 of 44 other breeds. Twenty-eight dogs were of mixed breeds. Ages ranged from 3 to 205 months (median, 96 months) in dogs with intracranial lesions and from 5 to 189 months (median, 90 months) in dogs without these lesions. Age, sex, and breed distribution were not significantly different between groups. Dogs with intracranial lesions weighed significantly ($P < 0.001$) less (17.8 ± 12.9 kg [39.16 ± 28.38 lb]) than dogs without intracranial lesions (23.8 ± 12.7 kg [52.36 ± 27.94 lb]).

Dogs with intracranial lesions had a significantly higher frequency of proprioceptive deficits (65/149 [44%] vs 14/89 [16%]; $P < 0.001$), cranial nerve deficits (35/149 [23%] vs 10/89 [11%]; $P = 0.025$), optic tract deficits (41/149 [28%] vs 6/89 [7%]; $P < 0.001$), abnormal mentation (57/149 [38%] vs 12/89 [13%]; $P < 0.001$), and circling behavior (34/149 [23%] vs 5/89 [6%]; $P < 0.001$) than did dogs without intracranial lesions. Other variables evaluated in the neurologic examination did not differ between groups. Eighty-one of 89 (91%) dogs without intracranial lesions had a CSF sample collected, compared with 67 of 149 (45%) dogs with intracranial lesions ($P < 0.001$).

Three of 149 (2%) dogs with and 0 of 89 dogs without intracranial lesions developed severe perianesthetic complications; this difference was nonsignificant ($P = 0.29$). All 3 dogs with severe complications required use of a ventilator following anesthesia, and 2 of these were euthanized owing to a combination of a guarded prognosis and financial considerations of ventilation; no other perianesthetic deaths were recorded. Anesthetic records were not available for 7 dogs, but it was determined from the remainder of the medical record that they did not develop severe perianesthetic complications; these dogs were grouped with those that did not have prolonged anesthetic recovery for statistical analysis to underestimate rather than overestimate the frequency of this outcome. Anesthetic records that included time to extubation were available for 111 (74%) dogs with and 64 (72%) dogs without intracranial lesions. Time to extubation from the end of anesthesia was significantly ($P = 0.018$) longer in dogs with (median, 15 minutes) than in dogs without (median, 10 minutes) intracranial lesions. A significantly ($P = 0.011$) greater proportion of dogs with (20/111 [18%] than dogs without (3/64 [5%]) intracranial lesions had a prolonged anesthetic recovery.

Signalment, clinical signs, presumptive diagnosis, and anesthesia-related variables were compared between dogs that had perianesthetic complications (26/238 [11%]) and dogs that did not (212/238 [89%]). For this analysis, dogs that required use of a ventilator following anesthesia or had prolonged anesthetic recovery were grouped together as dogs with complications. Breeds with complications included French Bulldog (n = 4); Miniature Schnauzer, Miniature Pinscher, Greyhound, Labrador Retriever, German Shepherd Dog, and Boxer (2 each); and 1 each of 10 other breeds. Age, weight, and sex were not significantly different between dogs with and without complications. A significantly

($P = 0.002$) greater proportion of French Bulldogs (4/6) had complications, compared with other breeds, although only prolonged anesthetic recovery occurred in those dogs, and no French Bulldogs required a ventilator following anesthesia. Abnormal mentation prior to anesthesia was the only clinical sign that differed significantly between dogs with (15/26 [58%]) and without (70/212 [33%]) perianesthetic complications. Intracranial masses were diagnosed in 13 of 26 (50%) dogs with complications, compared with 56 of 212 (26%) dogs without complications ($P = 0.02$). There was no significant ($P = 0.29$) difference in the rate of seizures between dogs that did (11/26 [50%]) and did not have complications (81/212 [38%]).

During anesthesia, a period of hypotension was recorded for 15 of 26 (58%) dogs with and 113 of 212 (53%) dogs without complications ($P = 0.83$). Hypocapnia was detected in 10 (38%) dogs that had complications and 66 (31%) that did not ($P = 0.50$); hypercapnia was detected in 8 (31%) dogs that had complications and 52 (25%) that did not ($P = 0.48$). A ventilator was used during anesthesia in 25 (96%) dogs with and 201 (95%) dogs without complications ($P = 1.0$).

Anesthetic drug protocols varied greatly, but all were approved by a board-certified veterinary anesthesiologist or anesthesiology resident. Nitrous oxide was part of the anesthetic protocol in 0 of 26 dogs with and 2 of 212 dogs without complications, respectively. Premedication for dogs with complications included various combinations of butorphanol (n = 14), acepromazine (5), dexmedetomidine (4), diazepam (4), midazolam (4), meperidine (1), and morphine (1); 10 patients received no premedication. Dogs without complications received various combinations of butorphanol (n = 113), midazolam (39), dexmedetomidine (35), acepromazine (31), diazepam (21), hydromorphone (15), meperidine (6), glycopyrrolate (4), buprenorphine (3), morphine (1) and ketamine (1), as premedication; 63 patients received no premedication.

For anesthetic induction, dogs with complications received various combinations of propofol (n = 22), diazepam (15), butorphanol (7), thiopental (3), lidocaine (2), hydromorphone (1), and midazolam (1). Dogs without complications received various combinations of propofol (n = 189), diazepam (106), butorphanol (44), thiopental (12), midazolam (6), hydromorphone (4), etomidate (3), lidocaine (3), acepromazine (2) sevoflurane (via face mask; 2), ketamine (1), and fentanyl (1) in various combinations. No significant differences were found in the proportion of dogs with and without complications that received premedication or were administered any 1 drug in the premedication or anesthetic induction protocol. Additionally, type of inhalation anesthesia was not significantly ($P = 0.46$) different between dogs with (n = 22 and 4 for isoflurane and sevoflurane, respectively) and without complications (150, 49, and 6 for isoflurane, sevoflurane, and both drugs, respectively).

Fourteen of 26 (54%) dogs with complications received drugs intended to reduce inflammation or cerebral edema in the perianesthetic period. Of these, 3 received dexamethasone sodium phosphate alone and 11 received mannitol, furosemide, or both (8 with and 3 without dexamethasone sodium phosphate). Twenty-four of 212 (11%) dogs without complications received similar treatment; 9 received dexamethasone sodium phosphate alone, and 15 received mannitol, furosemide, or both (9 with and 6 without dexamethasone sodium phosphate). A greater proportion of dogs with complications received dexamethasone sodium phosphate with mannitol or with mannitol and furosemide ($P < 0.001$), but there was no significant difference in the proportion of dogs in each group that received mannitol, furosemide, or both ($P = 0.063$) or dexamethasone sodium phosphate alone ($P = 0.13$). Seven (27%) dogs with complications and 8 (4%) without complications received anesthetic reversal agents, including flumazenil, naloxone, and atipamezole, and this difference between groups was significant ($P < 0.001$).

## Discussion

The objectives of this study were to evaluate the occurrence of perianesthetic complications in dogs undergoing MRI for suspected intracranial disease and identify risk factors associated with observed complications. Magnetic resonance imaging was chosen as the only advanced imaging modality because of its superiority over CT for diagnosis of many types of intracranial lesions.[11,12] Use of a ventilator was required following anesthesia in 3 (2%) dogs with and 0 dogs without intracranial lesions; this was not a significant difference. Two of these 3 dogs were euthanized, but no other perianesthetic deaths occurred.

The present study may have underestimated the occurrence of various clinical signs and severe perianesthetic complications in dogs with intracranial lesions, because evaluations requiring general anesthesia may have been less strongly recommended by clinicians or may have been less frequently pursued by owners for patients with more severe clinical signs, including very abnormal mentation, owing to perceived risks. Although durations of anesthesia were subjectively similar among dogs, time to extubation was significantly different between dogs with and without intracranial lesions, with prolonged recovery time (> 20 minutes from the end to anesthesia to extubation) significantly ($P = 0.012$) more common in dogs with intracranial lesions. Many factors could have influenced this result, including clinician preference to extubate dogs with known intracranial lesions or abnormal mentation later than other patients, decreased gag reflex in some patients with neurologic disorders, and variability among individuals monitoring anesthesia. This variable would be best evaluated under conditions where specific criteria for extubation are established and reasons for delaying extubation (ie, lack of gag reflex vs continued lack of consciousness) are recorded.

A standard anesthetic protocol would also make interpretation of anesthetic recovery time more meaningful, although there were no significant differences in administration of any 1 drug in premedication or anesthetic induction protocols between dogs with complications (ie, those that had prolonged recovery time, required a ventilator following anesthesia, or died in the perianesthetic period) and dogs without complications.

The decision to define prolonged anesthetic recovery as > 20 minutes to extubation from the end of anesthesia was made to underestimate rather than overestimate the number of dogs that had this complication, thus minimizing to a certain extent some of the factors for delayed extubation. In a recent study[13] of dogs undergoing anesthesia for MRI of the brain, mean time to extubation was 7 minutes for dogs that received sevoflurane and 8 minutes for those that received isoflurane (a nonsignificant difference). In the present study, isoflurane, sevoflurane, or a combination of both drugs was used, but there was no significant ($P = 0.46$) difference in inhalation anesthesia selection between dogs with and without complications. Dogs with complications more commonly received anesthetic reversal agents ($P < 0.001$) and combinations of dexamethasone sodium phosphate with mannitol, furosemide, or both ($P < 0.001$), and this was likely in response to prolonged anesthetic recovery.

Dogs with intracranial lesions in our study weighed significantly ($P < 0.001$) less than dogs without intracranial lesions. This was likely because dogs with inflammatory brain disease are typically of small breeds and toy breeds, and other common intracranial diseases are not associated with size in dogs.[5,14–16]

In addition to evaluating perianesthetic complications in dogs with and without intracranial disease, we compared signalment, clinical signs, presumptive diagnosis, and anesthesia-related variables between dogs with and without perioperative complications. A significantly ($P = 0.002$) greater proportion of French Bulldogs developed complications in the form of prolonged anesthetic recovery time, compared with other breeds. This may have been at least partially attributable to the fact that this is a very common brachycephalic breed and it is common practice at the University of Minnesota Veterinary Medical Center to extubate brachycephalic dogs as late as possible because of airway conformation abnormalities. However, Pugs, another brachycephalic breed that was even more common in the data set, did not have any of the perianesthetic complications evaluated.

Abnormal mentation was the only clinical sign significantly ($P = 0.017$) associated with complications. This may have been attributable to this clinical sign occurring more frequently in dogs with increased ICP, more diffuse cerebral lesions, or lesions already affecting the ascending reticular activating system.[5,14–16] No attempt was made to compare dogs on the basis of the degree of change in mentation because of a lack of consistent descriptions of these changes in the medical records and presumed interobserver differences. Evaluation of medications administered to dogs, including anticonvulsants that may have led to the impression of abnormal mentation or slowed anesthetic recovery, was not performed; however, there was no significant ($P = 0.29$) difference in the rate of seizures between dogs with and without complications.

Thirteen of 26 (50%) dogs with perianesthetic complications had intracranial masses, and altered mentation was a common clinical sign among dogs with this diagnosis. The common forebrain location of intracranial masses and their tendency to increase ICP are likely explanations.[17,18] The high proportion of dogs with complications in the present study that had intracranial masses is not surprising, given the known association between masses and increased ICP[19,20] and the common finding that peritumoral edema can extend the lesion's effect outside of the boundaries of the mass itself.[11,17,18] Although it was beyond the scope of our study, evaluation of specific MRI findings (eg, size, location, and associated edema) for masses in dogs that developed complications versus those that did not would potentially be beneficial because it could improve clinical decision making for dogs with prolonged recovery times and also lead to evaluation of treatments during anesthesia that could improve the chance of successful anesthetic recovery.

One limitation of this study was that presumptive rather than definitive diagnosis of intracranial lesions was used in most cases. Magnetic resonance imaging is considered to be highly sensitive for detection of intracranial masses but is less sensitive for detection or differentiation of other types of lesions, including inflammatory and vascular diseases.[11,21–30] Definitive diagnosis of lesions requires histologic evaluation, which can be performed in living patients[31–36] but is often only achieved on postmortem examination. Only a few dogs of the present study had necropsy performed; histologic evaluation of masses after surgical resection was more common. Because the number of definitively diagnosed masses was small, no attempt was made to evaluate perianesthetic complications among specific tumor types. However, in our opinion, the size and location of a lesion are more likely to influence development of perianesthetic complications than is the specific lesion type.

Other important factors to consider when evaluating the results of the present study are that substantial differences in training were likely to exist among different clinicians performing neurologic examinations, and no effort was made to control for the variability in time between this examination and the anesthetic episode for MRI. In a prospective study, this would be addressed by having 1 veterinary neurologist evaluate all dogs immediately prior to premedication for anesthesia and MRI.

The retrospective nature of the present study was another important limitation. Only 238 dogs were included in the study; if the difference in frequency of a given complication between dogs with and without intracranial lesions was small, the sample size may have been inadequate to detect a difference. Retrospective studies are also subject to observational bias because of differing habits with regard to thoroughness and accuracy in clinicians' record keeping.

Evaluating perianesthetic risk for diagnostic procedures in veterinary patients with suspected intracranial lesions is extremely important in that it allows clinicians and owners to make informed decisions regarding anesthesia. Determination of risk factors for these patients creates opportunities for evaluating potential protocols or treatments prior to or during anesthesia aimed at improving anesthetic recovery. Such measures have been evaluated in animals undergoing craniotomy,[37] and quality and speed of recovery in dogs undergoing MRI of the brain have been assessed,[13,38] but to our knowledge, the frequency of perianesthetic com-

plications in dogs undergoing MRI for this purpose has not been previously evaluated.

In the present study, dogs with intracranial lesions had a higher incidence of certain perianesthetic complications, such as prolonged anesthetic recovery, compared with dogs without intracranial lesions. Although only dogs with intracranial lesions developed severe perianesthetic complications (ie, need for a ventilator after anesthesia or perianesthetic death or euthanasia), the difference between dogs that did and did not have intracranial lesions was nonsignificant and the overall severe complication rate (3/238) was considered low.

a. GraphPad Prism, version 6.00 for Windows, GraphPad Software, La Jolla, Calif.

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