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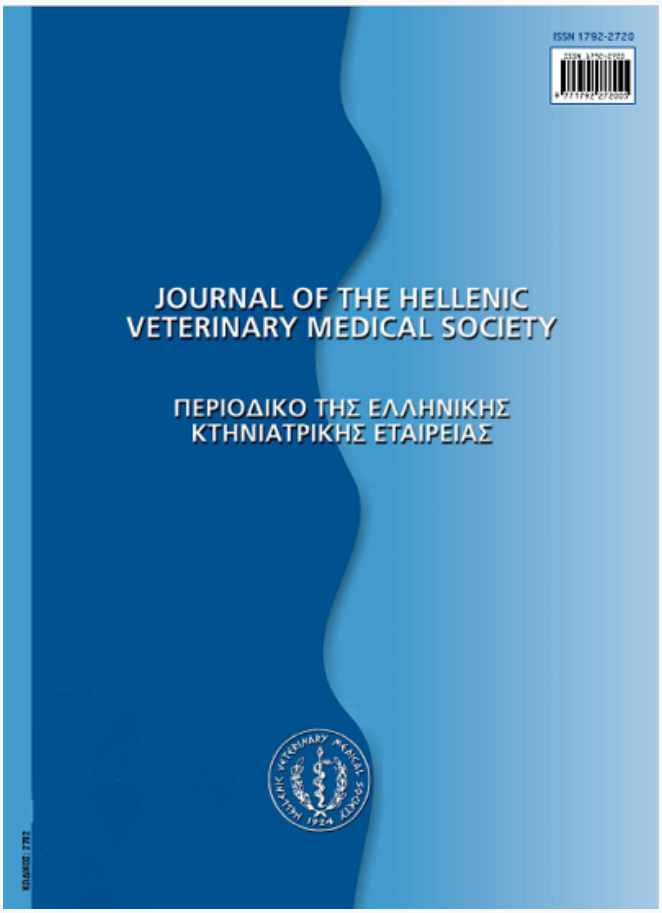

Acute hypoadrenocorticism (adrenal crisis) in the dog: a report on six clinical cases

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Acute hypoadrenocorticism (adrenal crisis) in the dog: a report on six clinical cases.

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Οξύς υποφλοιοεπινεφριδισμός (αδισσώνια κρίση) στο σκύλο: αναφορά σε έξι περιστατικά.

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ABSTRACT. Medical records of six dogs admitted with acute hypoadrenocorticism were reviewed. All 6 animals were bradycardic and had prolonged capillary refilling time. Hypothermia was detected in 5/6 animals. Clinicopathological evaluation on admission revealed anemia (3/6 dogs), increased (2/6) and normal (2/6) lymphocyte and eosinophil counts, azotemia and hyperkalemia (6/6), hyponatremia, in 5/6 dogs in which sodium was measured with a sodium (Na) : potassium (K) ratio lower than 24, hypoglycemia (2/6) and hypercalcemia, hypocholosterolemia, increased serum alkaline phosphatase and alaninoaminotransferase activities, one dog each. Urine specific gravity was lower than 1025 in 4 dogs. Thoracic radiographs and abdominal ultrasonography disclosed microcardia (2/6), pleural effusion (2/6) and ascites (1/6). Two dogs (2/6), also, presented atrial standstill or atrioventricular block, detected on electrocardiograms. In all 6 animals emergency treatment included the use of intravenous normal saline and

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glucocorticoids (dexamethasone) immediately after the completion of an ACTH stimulation test with tetracosactide. Two dogs died, one during the 1st day and the other on the 4th day of hospitalization, the latter after the sudden appearance of severe hemorrhagic gastroenteritis. Hospitalization time in the remaining 4 dogs ranged from 3 to 10 days. Prolongation of hospitalization was associated with worsening of anemia, hypoalbuminemia, neurologic complications and non-responsive azotemia. Four dogs (4/6) were discharged on oral prednisolone and fluodrocortisone, but one died after a week for unknown reasons. Acute hypoadrenocorticism is a life-threatening condition requiring emergency treatment for a successful outcome. Its inclusion in the differential diagnosis of canine emergencies, presented with acute weakness and gastrointestinal signs, is mandatory, but for its confirmation a complete laboratory and, most importantly, an ACTH stimulation test are always required.

Keywords: acute hypoadrenocorticism, emergency treatment, ACTH stimulation test, maintenance treatment.

ΠΕΡΙΛΗΨΗ. Και οι έξι σκύλοι που προσκομίστηκαν με οξύ υποφλοιοεπινεφριδισμό (αδισσώνια κρίση) την περίοδο 2008-2010 παρουσίαζαν βραδυκαρδία και αυξημένο χρόνο επαναπλήρωσης των τριχοειδών. Υποθερμία παρουσίαζαν 5 στους 6 σκύλους. Στην εργαστηριακή διερεύνηση που ακολούθησε διαπιστώθηκε αναιμία (2/6 σκύλους), φυσιολογικός (2/6) και αυξημένος (2/6) αριθμός λεμφοκυττάρων και εωσινοφίλων, υπερκαλιαιμία και αζωθαιμία (6/6) και υπονατριαιμία με διαταραχή του λόγου νατρίου : καλίου σε 5 ζώα στα οποία μετρήθηκε το νάτριο. Δύο ζώα, επίσης, παρουσίασαν υπογλυκαιμία, ενώ στα άλλα παθολογικά ευρήματα περιλαμβάνονταν η υπεραβεστιαιμία, η υποχολοστερολαιμία και η αύξηση της δραστηριότητας της αλκαλικής φωσφατάσης και της αλανινοαμινοτρανσφεράσης, από ένα για κάθε περιστατικό. Το ειδικό βάρος των ούρων ήταν κάτω από 1025 σε 4/6 ζώα, στην ακτινολογική και την υπερηχοτομογραφική εξέταση διαπιστώθηκαν μικροκαρδία (2/6), ασκίτης (1/6) και πλευριτική συλλογή (2/6). Κολποκοιλιακός αποκλεισμός και κολπική ασυστολία διαπιστώθηκαν με το ηλεκτροκαρδιογράφημα σε 2/6 περιστατικά. Σε όλα τα ζώα έγινε ενδοφλέβια θεραπεία με φυσιολογικό ορό και δεξαμεθαζόνη αμέσως μετά τη δοκιμή διέγερσης με τετρακοσακτίδη (ACTH). Δύο από τα 6 ζώα πέθαναν, το ένα μέσα στο πρώτο εικοσιτετράωρο και το άλλο την 4η ημέρα της νοσηλείας, λόγω έντονης αιμορραγικής γαστρεντερίτιδας. Η διάρκεια νοσηλείας για τα υπόλοιπα ζώα κυμάνθηκε από 3 μέχρι 10 ημέρες. Παρατεταμένη νοσηλεία χρειάστηκαν οι σκύλοι εκείνοι που παρουσίασαν αναιμία, υπολευκωματιναιμία, νευρικά συμπτώματα και εμμένουσα αζωθαιμία. Από τους 4 επιζώντες σκύλους που στάλθηκαν στο σπίτι με πρεδνιζολόνη και οξεϊκή φθοριοκορτιζόνη από το στόμα, ο ένας πέθανε για άγνωστους λόγους ύστερα από μια εβδομάδα. Η αδισσώνια κρίση αποτελεί μια επείγουσα παθολογική κατάσταση που απειλεί άμεσα τη ζωή του σκύλου και πρέπει να αντιμετωπίζεται ανάλογα. Η διαφοροποίησή της από άλλες επείγουσες παθήσεις του σκύλου που χαρακτηρίζονται από αιφνίδια αδυναμία και γαστρεντερικές διαταραχές πρέπει να στηρίζεται στην προσεκτική αξιολόγηση των αποτελεσμάτων της εργαστηριακής εξέτασης και τη δοκιμή διέγερσης με τετρακοσακτίδη (ACTH).

Λέξεις ευρετηρίασης: υποφλοιοεπινεφριδισμός, επείγουσα θεραπεία, δοκιμή διέγερσης με ACTH (τετρακοσακτίδη), γλυκοκορτικοειδή.

INTRODUCTION

Naturally occurring hypoadrenocorticism is an uncommon endocrinopathy in the dog with a prevalence ranging from 0.06% to 0.28% among the admitted cases (Kelch et al. 1996, Scott-Moncrief 2009). Although primary adrenocortical failure may be due to granulomatous inflammation, hemorrhagic infraction, amyloidosis, necrosis or neoplasia of the adrenal cortex, its main cause is most likely that of immune-mediated etiology (Boujon et al. 1994). Iatrogenic adrenal failure is common and follows the treatment of hyperadrenocorticism with mitotane or trilostane (Nieger et al. 2002, Lathan and Tyler 2005a, Scott-Moncrief 2009). Acute hypoadrenocorticism (adissonian or adrenal crisis), has been recognized as a true endocrine emergency with approximately 30% of dogs with hypoadrenocorticism admitted to critical care units (Feldman and Nelson 2004, Lathan and Tyler 2005a). Its clinical picture is quite variable, thus explaining the similarities sharing with other more common acute conditions. The recognition of the acute disease, as early as possible, is crucial for a favourable outcome, because the long-term prognosis in the most of these cases is actually good, if an appropriate treatment is applied on time (Meeking 2007). In this report, the history, the clinical picture, the laboratory findings, the treatment and the outcome of 6 dogs admitted with acute hypoadrenocorticism are described and discussed accordingly.

MATERIALS AND METHODS

The medical records from an academic institution and three private veterinary clinics were reviewed for dogs presented with acute hypoadrenocorticism during a 2-year period (2008-2010). Selection criteria for the inclusion in the study were an acute weakness with collapse, complete medical history, laboratory compatibility and an ACTH stimulation test result

Table 1. Signalment, clinical signs and outcome in 6 dogs presented with acute hypoadrenocorticism (adrenal crisis).

Cases Nº	Breed	Gender	Age (years)	Clinical signs (on admission)	Outcome
1	Mongrel	Male, neutered	8	Lethargy, rectal temperature: 35°C, *HR: 50†bpm, weak femoral pulses, ‡CRT: 4 sec, dehydration: 7-10%.	Died
2	Mongrel	Female, intact	8	Lethargy, rectal temperature: 36.3°C, HR: 40 bpm, weak femoral pulses, CRT: 4 sec, dehydration: 7%-10%.	Recovery
3	Mongrel	Male, intact	8	Lethargy, rectal temperature: 37.5°C, HR: 50 bpm, weak femoral pulses, CRT: 4 sec, dehydration: 7-10%.	Recovery
4	West Highland white terrier	Female, intact	1,5	Lethargy, rectal temperature: 36.5°C, HR: 60 bpm, weak femoral pulses, CRT: 5 sec, dehydration: 7-10%.	Died
5	Springer spaniel	Female, intact	6	Depression, rectal temperature: 38.1°C, HR: 40 bpm, weak femoral pulses, CRT: 5 sec,dehydration: 7-10%.	Recovery
6	Cocker spaniel	Male, intact	4	Lethargy, rectal temperature: 35°C, HR: 50 bpm, weak femoral pulses, CRT: 5 sec, dehydration: 7-10%.	Died

*HR: heart rate,† bpm: beats per minute, CRT: capillary refill time

typical for hypoadrenocorticism. Six animals met these criteria and were included in the study. ACTH stimulation test was performed with the use of tetracosactide (Synacthen® Novartis), to that cause, two blood samples were taken for cortisol measurement (serum), one just before and the other one hour after the intravenous injection of 125 μg/animal (body weight <5kg) or 250 μg/animal (body weight >5 kg), according to the laboratory instructions (Feldman and Nelson 2004). In every instance, the test was performed before or shortly after the dexamethasone administration (normal ranges for basal cortisol: up to 250 nmol/l, and post-ACTH up to 550 nmol/l, RIA methodology Cambridge Specialist Laboratory Services). The equipment employed for the laboratory evaluation of the dogs was the ADVIA 120 Hematology system, Bayer (complete blood count), Vitalab Flexor E, Vital Scientific (biochemistry samples).

RESULTS

1. Signalment, history, clinical and laboratory evaluation

The age of the dogs ranged from 2 to 8 years old, whereas regarding their gender, 3 were intact females, 2 intact males and 1 neutered male. Three of these animals were mongrels, while the other three purebreds (West Highland white terrier, Springer spaniel and Cocker spaniel) (Table 1). The duration of the clinical signs, prior to adrenal crisis, ranged from 1 day to 3 months and were consistent with lethargy and poor appetite (6/6), weight loss (cases 1 and 6), acute diarrhea and vomiting (case 2), chronic vomiting (case 6), muscle tremors (cases 2 and 4), pain episodes (case 2) and seizures plus neurologic deficits (case 4). The clinical signs of case 6 waxed and waned for as long as three months before the admission. Liver biopsies via laparotomy were obtained from case 4 because of the persistently increased hepatic enzyme activities in blood serum with the adrenal crisis to be witnessed soon after the recovery of the dog from anaesthesia. At the time of admission, all 6 animals were found to have dehydration, depression or lethargy, bradycardia, weak femoral pulses and hypothermia, apart from case 5 for the latter clinical sign (Table 1); three dogs (cases 1, 2 and 4) were, also, hypotensive (systolic blood pressure: 62-70 mmHg). Atrial standstill and atrioventricular heart block (A-V block) were documented with

Table 2. Pre-treatment hematological profile of 6 dogs admitted with acute hypoadrenocorticism (adrenal crisis).

	Clinical cases						
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**Reference ranges**
*HCT	36.5	49	53.9	36.1	47	35	37-52 %
Hemoglobin	14.6	16.5	17.3	12.1	16.7	17	13.2-19 g/dl
White Blood Cells	13000	10160	16400	7081	9600	11000	6000-12000/μl
Platelets	276000	361000	†ND	151000	341000	274000	150-500/μl
Lymphocytes	4200	2570	ND	1558	ND	4000	1000-3600/μl
Eosinophils	1100	437	ND	70	ND	900	0-600/μl

*HCT: Hematocrit, †ND: not done.

electrocardiogram (ECG) in dogs 4 and 5, whereas in the remaining cases, only sinus bradycardia was recorded. Cases 2 and 3 showed a rapidly progressive deterioration of clinical signs during the physical examination.

Complete blood count revealed a non-regenerative anemia in 3/6 dogs (cases 1, 4 and 6), while lymphocyte and eosinophil counts, measured in 4/6 animals, were found to be increased in dogs 1 and 6 and within reference range in dogs 2 and 4 (Table 2). All 6 dogs had increased serum creatinine and urea nitrogen concentrations, along with hyperkalemia. Sodium, measured in 5/6 dogs (cases 1, 2, 3, 5 and 6) was below reference ranges thus rendering a Na: K ratio lower than 27 (range 13 to 23.4). Other biochemical abnormalities noticed during the adrenal crisis were hypoglycemia (cases 3 and 4), increased serum liver enzyme (alkaline phosphatase, alaninoaminotransferase) activities (case 4), hypocholosterolemia and increased lipase activity (case 2), hyperphosphatemia (cases 2,3,5 and 6) and hypercalcemia (case 5) (Table 3). Urine specific gravity (SG) was ≤1025 in all 4 dogs in which it was measured (cases 2, 4, 5 and 6) ranging from 1007 to 1025. Thoracic radiography revealed microcardia in dogs 2 and 5, abdominal and pleural effusions in dog 4 and pleural effusion in dog 6; the effusions developed during the treatment period. Basal and post-ACTH cortisol was <20 nmol/l in all 6 dogs, thus confirming the diagnosis of hypoadrenocorticism.

2. Treatment and outcome

Normal saline was given intravenously soon after the admission of all 6 dogs. Colloid solution (Haes 10%, Steril®) was, also, given to dogs 1 and 2. In addition, dopamine (Giullidop®, Solvay), given as constant rate infusion, and hypertonic saline (NaCl 15%) injected as a bolus were administered to dog 2. Dextrose 5% was given intravenously in dogs 1, 3 and 4 during the hospitalization period enhanced with intermittent boluses of a hypertonic dextrose solution (35%) for the correction of hypoglycemia. Dexamethasone (Dexamethasone®, Alapis) was given to all 6 dogs, in doses ranging from 0.1-0.5 mg/kg. Three out of six animals showed marked clinical improvement within hours (cases 1, 3, 5). Azotemia was resolved within 48 hours after the initiation of treatment in all dogs, apart from dog 6 in which it lasted 5 days. Dog 4 presented generalized motor seizures that did not respond to propofol (Propofol-Lipuro®, Βιοσερ) drip and eventually died. In the remaining dogs (cases 1, 2, 3, 5, 6), intravenous prednisolone (Prezolon®, Nycomed Hellas) was administered at the dose of 0.1-0.5 mg/kg BID or TID. Anemia of dog 1 further deteriorated after an episode of severe gastrointestinal bleeding which led to oligemic shock and the death of the animal, despite the administration of a whole blood transfusion. On the 2nd day of hospitalization, dog 2 showed lethargy, ataxia, muscle tremors, proprioceptive and cranial nerve deficits (facial, trigeminal) that resolved progressively the following days; this dog was, also, hypoalbuminemic and anemic, but serum albumins and hematocrit were restored to normal values within 5 to 10 days post-admission respectively. On the 3rd day of hospitalization, dog 6 developed severe hypoalbuminemia and subcutaneous dependent edema plus pleural effusion. Because of the severe inspiratory dyspnea experienced by this dog, a thoracocentesis was attempted to drain as much as possible effusate. The animal was discharged on oral prednisolone (0.25 mg/kg, BID) and fludrocortisone acetate (Florinef®, Squibb) (0.1 mg/kg total daily dose) only to die one week later for unknown reasons. Dogs 1, 3, 5

Table 3. Pre-treatment biochemical profile on blood serum of 6 dogs admitted with acute hypoadrenocorticism (adrenal crisis).

	Cases						
Biochemical Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**Reference ranges**
Albumin	2.8	3.3	2.8	3.5	3.1	2.4	2.3-4.4 g/dl
*SUN	67	140	151	52	63	80	7-38 mg/dl
Creatinine	2.4	2.1	1.7	2.5	2.7	2.6	0.3-1.4 mg/dl
Glucose	91	80	30	61	104	100	60-143 mg/dl
Cholosterol	††ND	91	ND	ND	ND	ND	125-296 mg/dl
†ALP	10	63	163	750	42	84	20-212 U/l
‡ALT	61	39	152	335	40	56	10-118 U/l
§Total bilirubin	0.3	0.2	ND	0.1	ND	0.2	0.1-0.6 mg/dl
§Ca	11.6	10	9.1	10.8	15.2	10.2	7.9-12 mg/dl
¶P	7.2	9.7	ND	ND	16	12	2.5-6.8 mg/dl
£K	7.3	7.3	5,5	8.5	9,2	8.8	3.5-5.9 mmol/l
** Na	129	118	129	ND	120	125	135-160 mmol/l
Na:K	17.3	16.1	23.4	ND	13	14.2	>27

*SUN: Serum Urea Nitrogen, †ALP: alkaline phosphatase, ‡ ALT: alaninoaminotransferase, §Ca: calcium, ¶ P: phosphorus, £ K:potassium, ** Na: sodium, ††ND: not done.

that survived the adrenal crisis were discharged on oral prednisolone (0.25 mg/kg, BID) and fludrocortisones acetate (0.1 mg/kg total daily dose) and, at the time of writing this study, they are doing well according to the information obtained by phone contacts with the owners.

DISCUSSION

Three out of the 6 dogs had a period of illness extending up to three months before the appearance of the adrenal crisis. However, in one animal (case 6) the clinical signs waxed and waned during all this time. The information obtained from 506 dogs with hypoadrenocorticism have shown that the disease is rather chronic than acute, although veterinary assistance is sought usually only after the occurrence of an adrenal crisis (Feldman and Nelson 2004). In three of our dogs, adrenal crisis was precipitated by stressful events, such as physical examination (cases 2 and 3) or anaesthesia and liver biopsy (case 4). Another dog (case 1) showed mild general signs after a minor surgical procedure performed two months before the appearance of the adrenal crisis. In both humans and dogs, exacerbation of clinical signs in patients with subclinical glucocorticoid insufficiency may result from stressful events, such as boarding, grooming, surgical procedures, concurrent illness or even a visit to a veterinary practice (Lane et al. 1999, Klein and Peterson 2010a, Milenkovic et al. 2010).

The clinical signs of hypoadrenocorticism are generally non-specific, as it was the case in all 6 dogs, as well. Mucosal pallor, low rectal temperature and weak femoral pulses due to hypocortisolemia-induced circulatory collapse (Boysen 2008) can, also, be detected in other more common critical conditions. Bradycardia was recorded in all 6 dogs of this case series at the time of admission, although it is uncommon, occurring in approximately 22% of hypoadrenal dogs (Feldman and Nelson 2004). Nevertheless, when bradycardia is detected in animals with severe dehydration and circulatory collapse, the index of suspicion for hyperkalemia and possibly hypoadrenocorticism should be raised high (Lathan and Tyler 2005a, Greco 2007, Klein and Peterson 2010a).

As expected, two of the severely hyperkalemic dogs were presented with bradyarrhytmias, such as atrial standstill (case 4) and AV block (case 5). Hyperkalemia-induced cardiac arrhythmias are a common occurrence in canine hypoadrenocorticism and they include atrial standstill, sinus bradycardia, prolonged QRS duration, low R wave amplitude, high T wave amplitude, A-V blocks, atrial fibrillation and deviation of S-T segment (Feldman and Nelson 2004, Boysen 2008). However, the level of hyperkalemia is not always correlated with the severity and type of cardiac conduction abnormalities, especially when multiple electrolyte abnormalities are present (Tag and Day 2008).

Microcardia was visualized radiographically in two dogs (cases 2 and 5), one of which (dog 2) presented ascites and pleural effusion; another dog (case 6) had pleural effusion alone. Microcardia is a well-recognized radiographic finding in hypoadrenal dogs reported to occur in 30% to 50% of the clinical cases and it is most likely attributed to chronic hypovolemia and hypovolemic shock (Peterson et al 1996, Melian and Peterson 1999).

A non-regenerative anemia was detected in 3/6 dogs (cases 1, 4 and 6) at the time of their admission. Anemia, secondary to bone marrow suppression and acute or chronic gastrointestinal bleeding, has been reported to occur in 14.3-34% of hypoadrenal dogs (Willard et al. 1982, Melian and Peterson 1996, Peterson et al. 1996, Feldman and Nelson 2004, Hughes et al. 2007). However, dogs presented in adrenal crisis are usually hemoconcentrated and, therefore, show a falsely increased hematocrit, which eventually decreases after the rehydration of the animal (Feldman and Nelson 2004), as it was the case in two of our animals (dogs 1 and 2). Interestingly, the percentage of hypoadrenal dogs with anemia increased from 34% to 71% after 24 hours of fluid administration (Feldman and Nelson 2004). Therefore, rehydration may lead to a life-threatening anemia (case 1), thus necessitating whole blood or packed red blood cell transfusion (Medinger et al. 1993).

Absolute lymphocytosis and eosinophilia, detected in 2 (cases 1 and 6) out of 4 dogs in which the corresponding countings were performed, have been reported to range from 9% to 20.4% and 4.6%-20% of the affected dogs, respectively (Willard et al. 1982, Melian and Peterson 1996, Peterson et al. 1996, Feldman and Nelson 2004, Hughes et al. 2007). Both a normal lymphocyte count, occurring in up to 90% of hypoadrenal cases (Scott-Moncrief 2010), as well as lymphocytosis in a critically ill animal should raise high the suspicion for the disease (Lathan et al. 2005a).

Azotemia was a consistent finding in every instance. Serum creatinine and SUN concentrations normalized within 48 hours after the initiation of fluid treatment, apart from case 6. Azotemia in hypo-adrenocorticism is the direct result of reduced renal perfusion secondary to hypovolemia and hypotension and it is actually prerenal (Melian and Peterson 1996, Peterson et al. 1996, Hughes et al. 2007). Despite the prerenal origin of azotemia, many dogs presented with adrenal crisis have diluted urine, as it was demonstrated in 4/6 of our dogs in which the urine SG was ≤1025. Notably, 88% of 506 azotemic dogs with hypoadrenocorticism had urine SG lower than 1030 (Feldman and Nelson 2004). This dilutional effect is the result of reduced medullary concentration gradient because of chronic sodium loss (Boyssen 2008). Rapid restoration of renal parameters with treatment is usually of great help in the differentiation between primary renal failure and hypoadrenocorticism (Greco 1997).

Abdominal and/or pleural effusion in two of the dogs has not been reported in canine hypoadrenal patients, but severe hypoalbuminemia, occurring after the rehydration of these animals, would explain that finding. Hypoalbuminemia in hypoadrenocorticism may occur secondarily to gastrointestinal blood or protein loss, anorexia and/or decreased hepatic synthesis (Langlais-Burges 1995, Scott-Moncrief 2009).

Hypoalbuminemia along with increased alkaline phosphatase and alaninoaminotransferase activities (case 4) and hypocholosterolemia (case 2) could be attributed to concurrent hepatopathy, also seen in hypoadrenocorticism (Feldman and Nelson 2004). Liver damage may be due to chronic hypovolemia and/or hypotension, thus making the differentiation of hypoadrenocortisism from either primary or secondary liver disease a real challenge.

Two dogs (cases 3 and 4) were hypoglycemic on admission, whereas another one (case 1) became so during its hospitalization. Glucocorticoid deficiency may lead to decreased glucose production from the liver and increased sensitivity of peripheral insulin receptors (Kelch et al 1998), thus explaining the relatively high frequency of hypoglycemia seen in this disease (Peterson et al. 1996, Melian and Peterson 1996, Hughes et al. 2007, Klein and Peterson 2010a). Seizures of dog 4 could have hypoglycemia as an underlying cause, although it eventually died despite appropriate treatment. Glucocorticoid and glucose supplementation is usually successful in the treatment of hypoadrenal hypoglycemia (Schaer 2001) as it was witnessed in dogs 1 and 3.

Subclinical hypercalcemia, which is relatively common in this disease, is influenced by the degree of patient dehydration and is directly correlated with severity of the illness (Feldman and Nelson 2004,

Adamantos and Boag 2008). Surprisingly, the only hypercalcemic animal detected (case 5) was the most hypekalemic. Although 10 out of 40 hypercalcemic dogs were diagnosed to suffer from hypoadrenocorticism in one study (Elliot et al. 1991), the pathogenesis of hypercalcemia is poorly understood at the moment (Ramsey et al 2005, Gow et al 2007).

The fact that 5 of the animals were both hyperkalemic and hyponatremic and had a Na/K ratio less than 27 (13-23.4) would provide evidence to characterize their hypoadrenocorticism primary aldosterone deficiency (Boyssen 2008). However, the measurement of endogenous ACTH in plasma and, perhaps, pituitary and adrenal imaging would make the differentiation from the secondary form more solid (Feldman and Nelson 2004). In previous studies, renal and urinary tract disorders, gastrointestinal disease, pancreatitis, pleural effusions and liver failure were more often associated with a lower than 27 Na:K ratio than hypoadrenocorticism itself (Roth and Tyler 1999, Son-Il-Park 2000, Nielsen et al. 2008). However, the fact of the lower than 24 Na:K ratio in all 5 dogs may facilitate the differentiation from the aforementioned diseases, since the specificity of this cut-off value is approaching 100% (Adler et al. 2007).

Diagnosis of hypoadrenocorticism, with ACTH stimulation test is a test to be done prior to glucocorticoid administration to avoid misleading results (Klein and Paterson 2010b) and a diagnostic necessity in all suspicious of hypoadrenocorticism dogs regardless of their Na : K ratio (Lathan and Tyler 2005b).

Aggressive fluid therapy was instituted in all 6 dogs with the use of normal saline because it does not contain potassium and it is relatively high in sodium (Boysen 2009, Greco 2007). No additional medication is usually needed even with marked hyperkalemia, as it is usually corrected with normal saline (Lathan and Tyler 2005b, Klein and Peterson 2010b), which was also witnessed in 5 of our dogs that survived the first 24 hours of hospitalization. Dexamethasone is the glucocorticoid of choice and should be given even before the confirmation of diagnosis, despite the fact that the animal may actually be suffering from another disease also requiring emergency treatment (Schaer 2001). As expected, 3/6 dogs (cases 1, 3, 6) showed a spectacular improvement within hours (Feldman and Nelson 2004).

The neurologic signs of dog 2 on the 2nd day of hospitalization could be attributed to the rapid correction of chronic hyponatremia with hypertonic saline which may lead to cerebral and cerebellar demyelination similar to central pontine myelinolysis described in humans (Churcher et al. 1999) and dogs (MacMillan 2003).

Four dogs (cases 2, 3, 5, 6) survived the adrenal crisis and were discharged on oral medication, while the rest eventually died (cases 1, 4). The prolonged hospitalization period of case 2 (10 days) could be attributed to the complication of anemia (Feldman and Nelson 2004).

CONCLUSIONS

The long-term prognosis in hypoadrenal dogs, when treated appropriately, is usually favourable (Kintzer and Peterson 1997). The recognition of acute adrenal crisis as an emergency situation and its intensive treatment with normal saline and steroids may add to that, regardless of its diagnostic confirmation or the clinical similarities to other more common acute diseases.

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