Nontraumatic rupture of an adrenal gland tumor causing intra-abdominal or retroperitoneal hemorrhage in four dogs

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- Nontraumatic rupture of adrenal gland tumors in dogs can result in life-threatening blood loss into the peritoneal cavity or retroperitoneal space.
- In dogs with nontraumatic rupture of an adrenal gland tumor and resulting life-threatening hemorrhage, hemodynamic stabilization followed by adrenalectomy is the treatment of choice.

An 8-year-old spayed female Siberian Husky (dog 1) was brought to the **University of California, Davis, Veterinary Medical Teaching Hospital (UCD-VMTH)** because of lethargy and tachypnea of acute onset. On physical examination, the dog was obtunded and had faint heart sounds, hypodynamic femoral pulses, pale mucous membranes, a prolonged **capillary refill time (CRT)**, and a tense abdomen. Hemodynamic support was provided with bolus IV administration of isotonic crystalloid fluids over 30 minutes (bolus administration rate = 45 to 90 ml/kg of body weight [20 to 41 ml/lb]; exact amount administered was determined on the basis of clinical impressions of the dog's response), followed by administration of isotonic crystalloid fluids at 1.5 times the maintenance rate (maintenance rate = 60 ml/kg/d [27 ml/lb/d]). Samples were submitted for a CBC, serum biochemical analyses, and measurement of hemostatic parameters. The only abnormality was a high **serum alkaline phosphatase (ALP)** activity (201 U/L; reference range, 15 to 127 U/L). The PCV was 40% with 282,600 reticulocytes/µl. **Prothrombin time (PT)**, **partial thromboplastin time (PTT)**, and concentration of **fibrin degradation products (FDP)** were within reference limits. On abdominal radiographs, a retroperitoneal soft tissue density could be seen; this density appeared to be more pronounced on the right of the abdomen and had displaced the small intestines ventrally and to the left **(Fig 1 and 2)**. During abdominal ultrasonography, a large mass was visualized. This mass was initially thought to be the spleen, but on follow-up ultrasonography the next morning, it was determined to be a 4 × 5-cm hypoechoic mass in the area of the left adrenal gland. Perirenal and sublumbar retroperitoneal fluid were also identified. As no intraperitoneal fluid was identified, abdominocentesis was not performed. On thoracic radiographs, the cardiac silhouette, caudal vena cava, and pulmonary vasculature were smaller than expected, which was considered consistent with hypovolemia. The PCV decreased from 40 to 24% during the first 12 hours of fluid therapy, and the **total protein (TP)** concentration decreased from 6.0 to 5.4 g/dl. The anemia and the ultrasonographic and radiographic abnormalities were consistent with continuing retroperitoneal hemorrhage, and exploratory celiotomy was planned.

Two units of stored packed RBC were administered IV before surgery, but the dog's PCV did not change. At surgery, retroperitoneal hemorrhage, more severe on the right and extending from the diaphragm to the pelvic inlet, was identified. A friable bleeding 4 × 5 × 4-cm left adrenal gland mass that encompassed and was adhered to the left renal vein was identified. Blunt dissection was used to debulk the mass and control ongoing hemorrhage. Complete resection was not possible. Removal of the retroperitoneal blood was not attempted, as the source of continued hemorrhage had been identified and eliminated. The right adrenal gland appeared grossly normal. Approximately 1 L of blood was lost during surgery, and 2 additional units of packed RBC and 1.2 L of lactated Ringer's solution were administered to maintain blood circulating volume and pressure during surgery. Infrequent unifocal **ventricular premature contractions (VPC)** were seen on **electrocardiograms (ECG)** obtained during surgery.

Postoperative treatment included IV administration of isotonic crystalloid fluids at 1.5 times the maintenance rate and administration of oxymorphone (0.5 mg/kg [0.23 mg/lb], SC, q 4 h) and cefazolin (22 mg/kg [10 mg/lb], IV, q 12 h). Prophylactic treatment with heparin (100 U/kg [45 U/lb], SC, q 8 h) was administered for 3 days in an attempt to decrease the risk of thromboembolic complications. Within 24 hours after surgery, the dog was bright, alert, and responsive. Dosages of the crystalloid fluids and oxymorphone were gradually reduced until administration was discontinued. The ECG was monitored continuously after surgery, and during the first 36 hours after surgery, the frequency of VPC increased and periods of intermittent tachycardia (HR > 180 beats/min for no longer than 30 seconds) were detected. These abnormalities resolved without antiarrhythmic medication. The dog was discharged 4 days after surgery with instructions to

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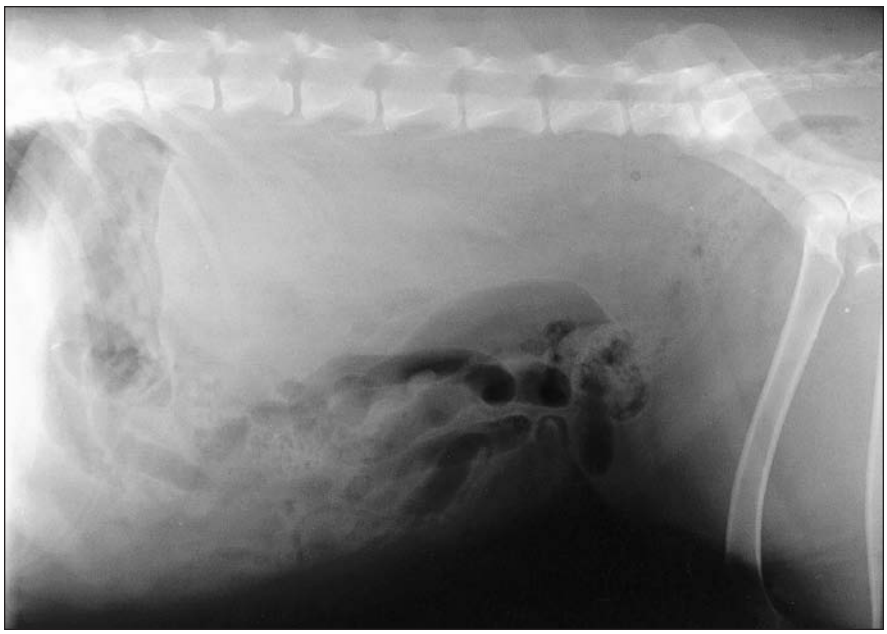

Figure 1—Lateral radiographic projection of the abdomen of a dog with retroperitoneal hemorrhage secondary to rupture of an adrenal gland tumor. Notice the ventral displacement of the intestines by a retroperitoneal soft tissue density.

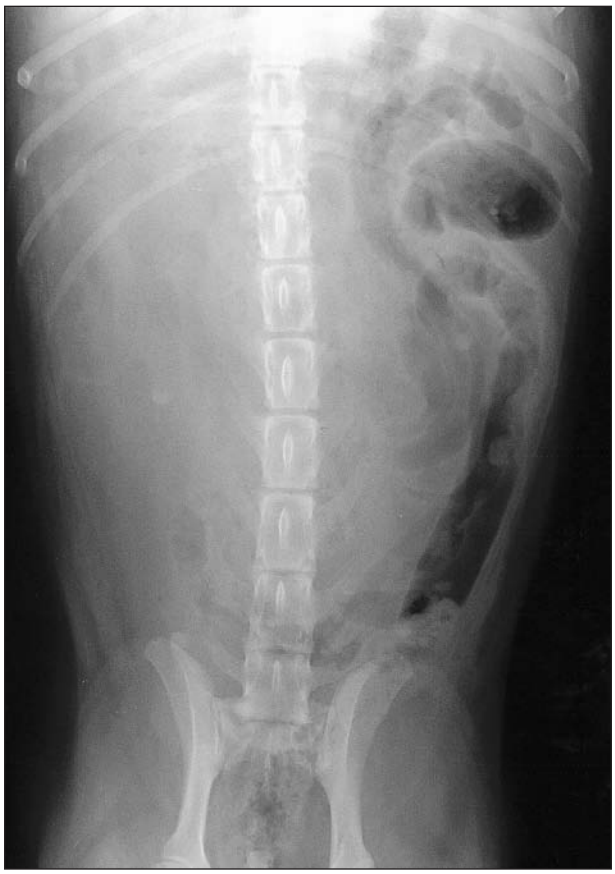

Figure 2—Ventrodorsal radiographic projection of the dog in Figure 1. Notice that the intestines have been displaced to the left.

administer cephalexin (25 mg/kg [11 mg/lb], PO, q 12 h) for 14 days. Histologic examination of the mass revealed adrenocortical carcinoma with vascular invasion. The retroperitoneal hemorrhage appeared to have resolved on radiographs obtained 10 days after surgery. At the last recheck examination, 9 months after surgery, the dog was healthy.

A 9-year-old male Doberman Pinscher (dog 2) was brought to the UCD-VMTH because of an acute onset of lethargy, tachypnea, and weakness. On physical examination, the dog was mildly obtunded and hypothermic (rectal temperature, 36.2 C [97.1 F]) with pale mucous membranes and a prolonged CRT. Heart rate was 120 beats/min with normal to bounding pulses. Ascites was detected during abdominal palpation; abdominal palpation also elicited signs of pain. The PCV was 27%, TP concentration was 5.0 g/dl, and venous pH was 7.23. One unit of packed RBC was administered IV, along with isotonic crystalloid fluids at 1.5 times the maintenance rate. Ascites was evident on abdominal radiographs, and a large mixed echogenicity mass in the area of the left adrenal gland was identified during abdominal ultrasonography. Abdominocentesis yielded blood (PCV, 26%; TP concentration, 4.7 g/dl) without evidence of erythrophagocytosis, which is most consistent with recent hemorrhage. Thoracic radiographs were unremarkable. After the initial 6 hours of fluid therapy, the anemia (PCV, 17.1% with 25,300 reticulocytes/µl), hypoproteinemia (3.0 g/dl), and thrombocytopenia (60,000 platelets/µl) had worsened. Serum biochemical abnormalities included low albumin (1.5 g/dl) and globulin (1.5 g/dl) concentrations, but PT, PTT, and concentration of FDP were within reference limits. Three units of packed RBC and 1 unit of **fresh frozen plasma (FFP)** were given IV, but the dog's PCV did not change. Intermittent tachycardia (HR > 180 beats/min for no longer than 30 seconds) and rare unifocal VPC were seen on the ECG. Dyspnea developed and was unresponsive to oxygen supplementation in an oxygen cage, and exploratory celiotomy was planned.

After anesthesia was induced, the dog developed sustained ventricular tachycardia (HR > 260 beats/min). A bolus of lidocaine (2 mg/kg [0.9 mg/lb], IV) was administered, and a constant-rate infusion of lidocaine (80 µg/kg/min [36 µg/lb/min], IV) was begun to control the ventricular tachycardia. Hemoperitoneum was confirmed at surgery, and a left adrenal gland mass was identified. The mass was bleeding and adherent to, but not invading, the caudal vena cava. Resection of the mass was complicated by its friable nature and an inability to achieve adequate hemostasis. The owners were contacted, and they elected to have the dog euthanatized. Histologic examination of the mass revealed a malignant pheochromocytoma.

An 11-year-old spayed female Borzoi (dog 3) was brought to the North Carolina State University Veterinary Teaching Hospital because of an acute onset of dyspnea. The dog had received aspirin (20 mg/kg [9 mg/lb], PO, q 12 h) because of arthritis during the 3 weeks prior to evaluation. Pertinent history included a high respiratory rate and possible polydipsia of unknown duration. Mucous membranes were pale, and the CRT was prolonged; abdominal palpation elicited signs of pain. Hemodynamic support was provided through bolus IV administration of isotonic crystalloid fluids over 30 minutes, followed by administration of isotonic crystalloid fluids at 1.5 times the maintenance rate. Results of a CBC, serum biochemical analyses, and tests of hemostatic function were within reference limits. The PCV was 36%, with a TP concentration of 5.0 g/dl. During the initial treatment, the PCV decreased to 23%, and the TP concentration remained at 5.0 g/dl. Two units of packed RBC were administered IV, but the PCV continued to decrease to 11%, and the TP concentration decreased to 3.2 g/dl. A mass in the area of the left adrenal gland was identified during abdominal ultrasonography. Thoracic radiographs were unremarkable. Unifocal paroxysmal VPC developed (HR > 260 beats/minute for more than 30 seconds) and were treated with bolus administration of lidocaine (2 mg/kg, IV) followed by constant-rate IV infusion (70 µg/kg/min [32 µg/lb/min]). Exploratory celiotomy was planned.

During surgery, a 6-cm hematoma cranial to the left kidney was identified. Within the hematoma was a 2.5 × 1 × 1-cm bleeding adrenal gland mass. The mass was adherent to the caudal vena cava and had invaded the renal vein, causing thrombosis. The mass was bluntly dissected from the caudal vena cava and ipsilateral nephrectomy was performed because of the involvement of the renal vein.

Treatment after surgery included IV administration of isotonic crystalloid fluids (60 ml/kg/d [27 ml/lb/d]) and administration of morphine (0.5 mg/kg [0.23 mg/lb], IV, as a bolus, followed by 0.25 mg/kg/hr [0.11 mg/lb/hr], IV, as a constant-rate infusion), lidocaine (70 µg/kg/min, IV, as a constant-rate infusion), heparin (100 U/kg, SC, q 8 h), and cefazolin (22 mg/kg, IV, q 12 h). The dog also received 1 unit of packed RBC and 1 unit of stored plasma. Within 48 hours after surgery, the dog was bright, alert, and responsive. Six days after surgery, administration of all medications except cefazolin was discontinued. The dog continued to improve and was discharged 9 days after surgery. Histologic examination of the adrenal mass revealed pheochromocytoma with no evidence of renal invasion.

Eight months after surgery, the dog was brought to the referring veterinarian in apparent hypovolemic shock. Ascites and a hepatic mass were identified with abdominal ultrasonography. The dog was euthanatized, and a ruptured hepatic mass and hemoabdomen were found at necropsy. The owner declined histologic examination.

A 14-year-old spayed female English Springer Spaniel (dog 4) was brought to the UCD-VMTH because of an acute onset of lethargy and collapse. Decreased skin turgor and pale mucous membranes were evident on physical examination. Systolic blood pressure, measured by use of Doppler ultrasonography, was 110 mm Hg. Hemodynamic support was provided with bolus IV administration of isotonic crystalloid fluids over 30 minutes, followed by administration of isotonic crystalloid fluids at 1.5 times the maintenance rate. The PCV was 42%, and the TP concentration was 4.9 g/dl. Serum albumin concentration (2.5 g/dl; reference range, 2.6 to 4.3 g/dl) was slightly low, and serum ALP activity (210 U/L) and alanine transaminase activity (70 U/L; reference range, 5 to 60 U/L) were high. Thoracic radiographs were unremarkable. Unifocal paroxysms of VPC (HR > 180 beats/min for no longer than 30 seconds) and supraventricular premature contractions were evident on a continuous ECG. Antiarrhythmic therapy was not instituted.

The dog developed mild obtundation, reduced lung sounds ventrally, signs of cranial abdominal pain, and ascites during the next 12 hours. The PCV decreased to 31%, and the systolic blood pressure increased to 120 mm Hg. A 9 × 7-cm complex mass of mixed echogenicity cranial to the right kidney and in close association with the right liver lobe was identified during abdominal ultrasonography. Abdominocentesis yielded blood (PCV, 32%; TP concentration, 4.0 g/dl) without evidence of erythrophagocytosis, which is most consistent with recent hemorrhage. The PT, PTT, and FDP concentration were within reference limits. Tracheal narrowing, most pronounced at the thoracic inlet, mild shifting of the mediastinum to the right, atelectasis of right middle and accessory lung lobes, and mild pleural effusion were identified on thoracic radiographs. Analysis of the pleural fluid confirmed that it was a hemorrhagic effusion.

Exploratory laparotomy was performed because of the deterioration in the dog's clinical condition, the decrease in PCV, and the presence of an abdominal mass. One unit of packed RBC and 2.5 units of stored plasma were given IV during surgery. Hemoperitoneum and a 4 × 6 × 8-cm bleeding right adrenal gland mass closely associated with the caudal vena cava were identified. The mass was excised en bloc. The liver had rounded edges and was pale. Histologic evaluation of the mass revealed adrenocortical carcinoma with capsular invasion. Results of histologic examination of a liver biopsy specimen were consistent with centrilobular hypoxia, suggestive of hypoperfusion and anemia.

After surgery, the dog was given isotonic crystalloid fluids, IV, at 1.5 times the maintenance rate, oxymorphone (0.05 mg/kg, IV, q 4 h), and heparin (100 U/kg, SC, q 8 h). Bacterial culture of a urine sample obtained 1 day after surgery yielded *Klebsiella* spp susceptible to ticarcillin and clavulanic acid, and treatment with ticarcillin and clavulanic acid (50 mg/kg [23 mg/lb], IV, q 6 h) was instituted. Cardiac arrhythmias resolved approximately 36 hours after surgery. Pleural effusion and the mediastinal shift were more severe on follow-up thoracic radiographs obtained 24 hours after surgery, and respiratory distress had increased in severity. The dyspnea resolved after the dog was placed in an enriched oxygen environment (inspired O_2 fraction, 40%).

Bloodwork was repeated 36 hours after surgery, and abnormal results included a prolonged activated clotting time (139 seconds; reference range, < 120 seconds) and low PCV (23%) and TP concentration (4.1 g/dl). Two units of FFP were given, and fluid therapy was changed from administration of isotonic crystalloid fluids to administration of colloidal fluids (hetastarch; 2.5 ml/kg/h [1.1 ml/lb/h], IV) for 12 hours; administration of crystalloid fluids (50 ml/kg/d, IV) was then reinstituted. Three days after surgery, the pleural effusion and mediastinal shift had begun to resolve on follow-up thoracic radiographs, and administration of supplemental oxygen was discontinued. Dosages of all medications except antibiotics were tapered, and administration was discontinued. The dog continued to improve and was released on day 7. At a final recheck examination 5 months after surgery, the dog was healthy and active.

The causes of intraperitoneal and retroperitoneal hemorrhage are diverse but can be broadly classified into traumatic conditions and naturally occurring diseases. The most common causes of nontraumatic retroperitoneal hemorrhage in human beings include coagulopathies, rupture of vascular anomalies, renal cell carcinoma, angiomyolipoma, pancreatitis, and primary adrenal gland tumors.[1-3] To the authors' knowledge, a comprehensive list of nontraumatic causes of retroperitoneal hemorrhage in dogs has not been published, but causes that should be considered include coagulopathies, renal and adrenal gland tumors, retroperitoneal foreign bodies, and vascular anomalies. One of the authors (AEK) has examined a dog with retroperitoneal hemorrhage associated with rupture of a retroperitoneal hemangiosarcoma.

Dogs with adrenal gland masses usually have endocrinopathies such as hyperadrenocorticism.[4] Some adrenal gland tumors invade the local vasculature,[4,5] and naturally occurring hemorrhage is a rare but potentially life-threatening consequence of adrenal gland neoplasia. In a previous report,[6] a dog with signs of hyperadrenocorticism was examined because of a 3-day history of trembling and a "hunched back." Physical examination findings included signs of abdominal pain, decreased mentation, and prolonged CRT, and hemorrhage from an adrenocortical tumor was identified. A mare examined because of acute colic that was found to have a ruptured pheochromocytoma has also been described.[7] Physical examination findings included dehydration, signs of abdominal pain, an absence of intestinal sounds, and a distended cecum and left colon on palpation per rectum. Human beings with bleeding adrenal gland masses usually have a primary complaint of abdominal pain and are not typically in hypovolemic shock.[3,8-10]

The present report describes 4 dogs with naturally occurring adrenal gland rupture. Severe lethargy, weakness, and pale mucous membranes were reported for all 4 dogs. Signs of abdominal pain were detected during physical examination but were not the primary reason the dogs were brought for treatment. Three of the dogs did not have any history or clinical signs suggestive of adrenal gland-dependent hyperadrenocorticism or a pheochromocytoma; the remaining dog had a vague history of panting and polydipsia, which could be consistent with a pheochromocytoma or hyperadrenocorticism.[5]

In all 4 dogs, VPC developed before or during anesthesia, but timing of the arrhythmias did not correlate with periods of hypotension, and the VPC probably resulted from myocardial hypoxia and ischemia secondary to hypovolemia. In 2 dogs, the arrhythmias were considered hemodynamically unimportant and resolved without treatment. In the other 2 dogs, the arrhythmias resulted in heart rates > 260 beats/min for longer than 30 seconds, and antiarrhythmic therapy was considered necessary.

Emergency evaluation of a dog with intraperitoneal or retroperitoneal hemorrhage should include abdominal ultrasonography, abdominocentesis, thoracic radiography, routine bloodwork (CBC, serum biochemical analyses), and an assessment of hemostatic parameters (PT, PTT, and FDP concentration). Abdominal and thoracic radiography and ultrasonography were useful in differentiating intraperitoneal from retroperitoneal blood loss in these dogs and in identifying masses in the region of the adrenal gland; we also performed these procedures to look for evidence of metastatic lesions. Abdominal ultrasonography was more informative than radiography, because it allowed evaluation of the adrenal glands and revealed changes in adrenal gland echogenicity in 3 dogs. One of the masses, however, was initially misidentified as the spleen. Advanced imaging techniques such as computer tomography and magnetic resonance imaging were not used because of the acute onset of illness in these dogs and the time required to complete and interpret such studies.

In these dogs, the decision to perform exploratory surgery was made on the basis of continued deterioration in clinical condition, ongoing blood loss that was not responsive to blood volume restoration and blood component administration, and detection of an abdominal mass. Other indications for surgery may include an increase in the volume or PCV of intraperitoneal or retroperitoneal fluid and persistence of clinical signs associated with blood loss.[11] In all dogs, surgery was performed soon after stabilization of cardiovascular function and diagnosis of continuing intraperitoneal or retroperitoneal hemorrhage.

The goals of exploratory surgery in these dogs included achieving hemostasis to limit further blood loss, removal of any bleeding tissue, and acquisition of

samples to obtain a definitive histologic diagnosis. Adrenalectomy is technically demanding because of difficulties in exposing the adrenal glands and the proximity and possible involvement of adjacent vascular structures such as the caudal vena cava and renal vein.[11-13] A midline laparotomy was performed to permit full examination of the abdominal cavity, including examination of both adrenal glands and examination for intra-abdominal metastases. A paracostal approach for adrenalectomy has been described but provides limited exposure of the abdominal viscera. In 1 of these dogs, the tumor had extended into the renal vein, which necessitated nephrectomy.

Dogs in the present report had tumors of adrenocortical and adrenomedullary origin. Ruptured adrenal gland tumors are rare in human beings, with pheochromocytoma being the most common adrenal gland tumor causing hemorrhage in human beings. Rupture of myelolipomas, adrenocortical adenomas and carcinomas, and metastases have also been described.[2,3,8-10]

Results for these dogs suggest that adrenalectomy is indicated for management of a ruptured adrenal gland tumor in dogs and may be associated with a good short-term prognosis if the hemorrhage can be controlled and the mass removed. However, local recurrence of the tumor may be a problem because of incomplete excision of the mass. In addition, distant metastases may develop because of intraperitoneal seeding of tumor cells or hematogenous spread to distant sites.

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