The Use of Rim Excision as a Treatment for Canine Acanthomatous Ameloblastoma

This study reviews rim excision as a treatment for canine acanthomatous ameloblastomas (CAA) in dogs with <3 mm of bone involvement. Removal of a canine tooth was involved in 47% of the cases; 33% cases involved the caudal dentition. Follow-up ranged from 3 months to 5 years. No evidence of recurrence was seen. Client satisfaction with cosmesis and the animal’s ability to masticate was judged to be good. With appropriate case selection, rim excision appears to be a viable option for CAA and results in improved dental occlusion, cosmesis, and no evidence of epulis recurrence. J Am Anim Hosp Assoc 2010;46:91-96.

Introduction

Canine acanthomatous ameloblastoma (CAA) is characterized as a benign odontogenic tumor or epulis. The prevalence of epulides, including CAA, is not known. Routine histopathology of excised gingival masses is not always performed, which may skew the reported prevalence of CAA. In one clinicopathological study of canine epulides, acanthomatous epulides were reported to make up 18% of benign oral tumors. Yoshida et al found that on histopathological analysis, acanthomatous epulides had a marked invasion of the epithelium and recurrence after marginal excision. Moderate local invasion of the bone and induction of the periodontal ligament were seen, which differed from other epulides. 2

Canine acanthomatous ameloblastoma has undergone numerous terminology changes as the histopathological studies of oral tumors have redefined and reclassified epulides. In 1993, Gardner and Baker suggested that acanthomatous epulides were a type of ameloblastoma that developed from the gingival epithelium (peripheral) or from the alveolar bone (intraosseous). 3 Further study comparing these canine epulides to those seen in humans found numerous similarities between the canine acanthomatous epulis and the human interosseous ameloblastoma.

Treatment of CAA has evolved as more information regarding the nature of these oral tumors has been amassed. The difference in this benign soft tissue tumor compared to other odontogenic tumors is that it is locally invasive and has a high rate of recurrence following marginal resection. 4 In the dog, CAA have never been reported to metastasize. 5 Besides surgical intervention, irradiation and intralesional bleomycin have been used with varying success. 6

Currently the recommended treatment for CAA is radical surgical resection based on the site of the tumor (i.e., mandibulectomy or maxillectomy in the region of the tumor). 1,4,7 No incidence has been reported of recurrence of CAA after radical surgical resection of the affected area. Nonetheless, veterinary textbooks do mention another possible surgical procedure for benign masses: the rim excision or alveolar ridge resection. With rim excision, the ventral cortical bone of the mandible or the most dorsal portion of the maxillary or incisor bone remains intact 1,8 while the tumor, surrounding teeth, and periodontal structures are removed. The
advantages of rim excision over complete resection of the mandible include continuity of the jaw, decreased to absent mandibular drift, and improved dental occlusion. To our knowledge, the use of rim excision for CAA has not been reported in the veterinary literature. The goal of this study was to review the use of rim excision for the treatment of CAAs. It was hypothesized that with appropriate case selection, rim excision will prove curative, will bring an excellent return to function, and provide satisfactory cosmesis in the opinion of the clients.

Materials and Methods

Medical Records Review

The computerized records system was searched for maxillectomies and mandibulectomies performed at Veterinary Surgical Associates (VSA) from 2000 through 2007. Cases were included if the dog was diagnosed with an acanthomatous epulis or acanthomatous ameloblastoma. The remaining cases in which surgery was performed for neoplasia or fractures were excluded. The surgical reports were reviewed, and only dogs that underwent rim excision were included.

Criteria for rim excision included a gingival mass <2 cm in the largest dimension and <3 mm (approximately) of bone involvement adjacent to the tooth root (based on available dental radiographs). If the mass had been previously removed by the referring veterinarian, the gingival scar was used to determine the extent of previous excision and the width of margins of the rim excision.

Medical records of VSA were reviewed for signalment, location of the mass, surgical procedure, complications, and biopsy results. In addition to VSA records, follow-up after surgery was obtained from the referring veterinarians’ records. These records were reviewed for postoperative complications, recurrence of the mass, additional oral masses, or oral disease. When possible, clients were contacted during manuscript preparation, to determine if postoperative tumor development reoccurred. Clients were also questioned about their satisfaction with the procedure, their perception of cosmesis, and their dog’s prehension and mastication abilities.

Surgical Techniques

General anesthesia and perioperative pain medication were utilized in all cases, but protocol varied by surgeon preference. For mandibular CAAs, an incision was made through the gingiva encircling the mass and grossly involved dentition. A sagittal saw was used to cut the alveolar bone rostral, caudal, and ventral to the tooth roots, leaving the ventral mandible intact. A high-speed burr was used to remove any remaining tooth roots and periodontal ligament. Care was taken to remain dorsal to the mandibular artery and vein. Deep tissues and gingiva were closed using absorbable suture in a combination of suture patterns according to surgeon preference. In general, deep tissues were closed in a simple continuous pattern, and the mucosa was closed with a cruciate or simple interrupted suture pattern.

An osteotome was used to perform the rim excisions in the maxilla. When mild hemorrhage was encountered during maxillary rim excision, hemoclips were used for hemostasis. A high-speed burr smoothed bone edges and removed any remaining periodontal ligament. A buccal mucosal flap was elevated from the maxillary lip to close the defect.

Results

Case Selection

A total of 13 dogs were identified that had histopathological diagnosis of acanthomatous epulis/ameloblastoma and rim excision as the method of surgical removal. One additional dog (case no. 6) was reported as a “well-differentiated collagenous stromal proliferation” and was included in this study. One dog (case no. 8) had rim excision performed at two separate locations. At 9 years of age, the dog originally had a rim excision centered on the mandibular right third premolar for an acanthomatous ameloblastoma. This dog was presented the following year for evaluation of an acanthomatous ameloblastoma at the base of the first right mandibular premolar. Mandibular computed tomography (CT) identified the mass involving the tooth root of the right first mandibular premolar with close association to the second premolar and canine tooth root. No evidence of involvement with the previous resection was noted. Both tumors and results were included in the study as individual cases (case nos. 8, 9). Therefore, in total, this retrospective study included 14 dogs and 15 surgical procedures (cases) [see Table].

Due to the nature of this technique (i.e., the use of a burr), the surgical margins could not be accurately determined and were not available for histopathological review. Therefore, while histopathology was used to confirm the diagnosis of CAA, margins cannot be adequately evaluated to confirm removal of all microscopic disease.

Mean age for dogs at the time of surgery was 8.6 years (range 3 to 11 years). Thirteen (86.7%) of the 15 cases were ≥6 years of age at time of surgery. The remaining two cases were 3 and 5 years of age, respectively. Seven (50%) dogs were neutered males. One (7%) dog was an intact male, and six (42.8%) dogs were spayed females. The male to female ratio was 1.3.

Location of the Mass

Twelve cases involved mandibular rim excision. Distributions of right- and left-sided masses involving the mandible were 50% right-sided (six of 12) and 42% left-sided (five of 12); one (6%) mass was centralized at the left and right first and second incisors. Forty-seven percent (seven out of 15) of the cases involved the removal of a canine tooth. Thirty-three percent (five out of 15) involved the caudal premolars or molars. Incisor teeth were removed without removal of a canine tooth in 20% (three out of 15) of the cases. Three cases involved maxillary rim excision. One was centered on the right maxillary incisors, one was on the left incisors, and the third involved the left maxillary canine to the third premolar.
### Table
Clinical Data on 15 Cases of Rim Excision for Canine Acanthomatous Ameloblastoma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex * and Breed</th>
<th>Age (y) at Surgery</th>
<th>Side</th>
<th>Teeth Involved/Removed</th>
<th>Time to Follow-up Examinations</th>
<th>Complications</th>
<th>Client Satisfied?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SF golden retriever</td>
<td>11</td>
<td>Right</td>
<td>Canine</td>
<td>3 y</td>
<td>None at time of euthanasia (3 y postop)</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>SF golden retriever</td>
<td>3</td>
<td>Left</td>
<td>3rd incisor, canine and 1st premolar</td>
<td>5 y</td>
<td>None</td>
<td>Unable to contact</td>
</tr>
<tr>
<td>3</td>
<td>SF cocker spaniel mix</td>
<td>10</td>
<td>Left</td>
<td>3rd and 4th premolar</td>
<td>3 y</td>
<td>None at time of euthanasia (3 y postop)</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>SF boxer</td>
<td>6</td>
<td>Right</td>
<td>3rd premolar to 1st molar</td>
<td>2 y</td>
<td>Chews more on left side</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>NM border collie mix</td>
<td>8</td>
<td>Left</td>
<td>3rd incisor and canine</td>
<td>2 y</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>6†</td>
<td>NM Labrador retriever</td>
<td>5</td>
<td>Right</td>
<td>All incisors and canine</td>
<td>1 y</td>
<td>None</td>
<td>Unable to contact</td>
</tr>
<tr>
<td>7</td>
<td>NM English springer spaniel</td>
<td>11</td>
<td>Central</td>
<td>Right and left 1st and 2nd incisors</td>
<td>1 y</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>8‡</td>
<td>M Labrador retriever</td>
<td>9</td>
<td>Right</td>
<td>Canine</td>
<td>1.5 y</td>
<td>None</td>
<td>Unable to contact</td>
</tr>
<tr>
<td>9‡</td>
<td>M Labrador retriever</td>
<td>10</td>
<td>Right</td>
<td>1st to 3rd premolar</td>
<td>3 mos</td>
<td>None</td>
<td>Unable to contact</td>
</tr>
<tr>
<td>10</td>
<td>NM cocker spaniel</td>
<td>10</td>
<td>Left</td>
<td>Canine</td>
<td>1 y</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>11</td>
<td>NM Queensland heeler</td>
<td>10</td>
<td>Right</td>
<td>1st molar</td>
<td>7 mos</td>
<td>Ventral bony callus at surgery site, chews more on left side</td>
<td>Yes</td>
</tr>
<tr>
<td>12</td>
<td>NM Labrador retriever</td>
<td>9</td>
<td>Left</td>
<td>3rd and 4th premolar</td>
<td>3 mos</td>
<td>None</td>
<td>Unable to contact</td>
</tr>
</tbody>
</table>

(Continued on next page)
### Table (cont’d)

Clinical Data on 15 Cases of Rim Excision for Canine Acanthomatous Ameloblastoma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex and Breed</th>
<th>Age (y) at Surgery</th>
<th>Side</th>
<th>Teeth Involved/Removed</th>
<th>Time to Follow-up Examinations</th>
<th>Complications</th>
<th>Client Satisfied?</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>NM border collie mix</td>
<td>10</td>
<td>Left</td>
<td>2nd and 3rd incisors</td>
<td>3.75 y</td>
<td>None at time of euthanasia (3.75 y postop)</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>SF boxer mix</td>
<td>9</td>
<td>Right</td>
<td>1st and 2nd incisors</td>
<td>2.5 y</td>
<td>None at time of euthanasia (2.5 y postop)</td>
<td>Unable to contact</td>
</tr>
<tr>
<td>15</td>
<td>SF German shepherd dog mix</td>
<td>10</td>
<td>Left</td>
<td>Canine to 3rd premolar</td>
<td>1 y</td>
<td>Chews more on right side</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* SF=spayed female; NM-neutered male; M-intact male
† Histopathology: well-differentiated collagenous stromal proliferation
‡ Denotes dog had two surgeries 1 y apart
**Previous Medical History**
Seven cases had previous marginal excision at the referring veterinary hospital, and either the mass had recurred or incomplete excision was noted by histopathology. These dogs were then referred for more aggressive surgery. For the remaining cases, the referring veterinarians had a suspicion of CAA based on oral examination and, in some cases, dental radiography.

**Complications of the Procedure**
No intraoperative or perioperative complications were noted in the medical records of any of the 15 cases. Approximately 3 months after rim excision, one client noted a mass on the ventral aspect of the mandible in the area of the surgery (case no. 11). Oral examination revealed no further abnormalities. Mandibular radiographs were obtained that showed ventral callus formation at the junction of the caudal surgical site and normal jaw. A small fracture was noted as well [see Figure]. We suspect that the fracture was secondary to stress riser formation between jaw and surgical site because of the dramatic change in mandibular height at that location. The mandible was palpably stable and non-painful, and the client reported no difficulty during the dog’s mastication. No treatment was instituted. The radiographs also did not show any changes to the bone rostral or caudal to the surgical site that would indicate continued disease process.

**Postoperative Follow-up**
As indicated in the Table, owners from nine of the 15 cases were available for a follow-up telephone consultation during the preparation of this manuscript. Four dogs had been euthanized for diseases unrelated to this study. The follow-up period for these phone conversations ranged from 7 months to 3.5 years. All nine of the clients available reported no regrowth of the mass. All nine clients were satisfied with the surgical outcome and their dog’s ability to masticate and prehend food and toys. Three clients reported that their dogs chewed hard toys, balls, and bones on the contralateral side or didn’t chew as vigorously as previous to surgery. No client noted any problems with chewing kibble on the surgical side. No client expressed dissatisfaction with the cosmetics. Many clients reported that without an oral examination, they could not tell where surgery was performed. The follow-up examinations at VSA or the referring veterinarian’s ranged from 3 months to 5 years. No evidence of regrowth was seen on physical examinations.

**Discussion**
Classifications of ameloblastomas have been debated in both the human and veterinary literature. These tumors have been defined as benign, locally invasive, clinically malignant, and malignant. Metastasis has never been documented in dogs; however, in humans, malignant ameloblastomas and ameloblastic carcinomas have been noted to metastasize to the lungs, pleura, orbit, skull, and brain. In human ameloblastomas, histopathological categories include plexiform, unicystic, acanthomatous, granular, and follicular. A highly significant association has been seen between category of human ameloblastomas and recurrence. Follicular, granular cell, and acanthomatous types have a higher risk of recurrence and higher infiltrative tendency than other types. Veterinary studies do not describe cytological evidence of malignancy or cellular atypia, which makes it difficult to differentiate between the benign tumor reported in dogs and the potentially more aggressive variation seen in human ameloblastomas. Canine acanthomatous ameloblastomas are characterized by infiltration of the epithelial cell, few mitotic figures, cords or clusters of cells invading the submucosa, and local invasion of the surrounding bone. The variation in behavior of both the human and canine forms makes classification difficult and, correspondingly, the treatment decisions are debated. Local control and recurrence continue to be frustrating for clinicians. Histopathological studies have reported that 68% of CAA tumors recur after simple marginal removal. Therefore, more aggressive therapies such as radical wide excision, radiation, or intralesion bleomycin therapy have been recommended.

This paper reviews rim excision as an alternative surgical technique for management of CAA. With this technique, the mass, gingiva, involved teeth, and periodontal ligament are excised. The ventral cortex of the mandible or the dorsal aspects of the incisor or maxillary bones (depending on the tumor location) remain intact. Therefore, the risk for malocclusion is decreased, and cosmesis postoperatively is improved compared to the alternate surgical approaches. Our hypothesis was that with appropriate case selection, recurrence or recrudescence would not occur with rim excision. To our knowledge, this is the first case series of rim excision for the treatment of CAA.

Within this small number of cases, no evidence of tumor recurrence was seen. Due to the nature of this surgical technique, case selection was biased toward masses <2 cm in diameter with limited bone loss of <3 mm. The selection of
a small tumor size may have influenced the results and the lack of recurrence. We also cannot verify that adequate margins were achieved by histopathology, as the true surgical margin was removed with the burr drill and could not be submitted. Instead, follow-up data were reliant upon the clients’ reports of good function and lack of recurrence, as well as oral examinations noted within the medical records.

Marginal mandibulectomy techniques were first reported in the 1970s for human patients having a variety of oral carcinomas. Such techniques continue to be used today for humans with neoplasias such as squamous cell carcinoma and ameloblastomas. In human medicine, numerous imaging studies are undertaken to evaluate the extent of bony invasion before a surgical technique is recommended; these imaging studies include CT, bone scintigraphy, and magnetic resonance imaging (MRI). Resection of the jaw includes a 1.5- to 2-cm margin of normal bone from the radiological limit of the tumor. When possible, rim excision affords improved quality of life scores when compared to segmental resection. Similar to human patients, each client contacted in this study reported a high level of satisfaction with both the function and cosmesis of their dog’s mandible after rim resection for CAA. Reports state that in human ameloblastomas, the cancellous bone is invaded, but the Haversian systems of the cortical bone are not. Therefore, rim excision to maintain the ventral border is a suitable alternative to segmental resection.

In the study reported here, two findings were unexpected. The first was the dog that underwent rim excision for two separate CAA lesions. While both masses were in the right mandibular quadrant, CT analysis did not reveal continuation of the second mass from the more caudal location of the first rim excision. Since full mandibulectomy and histopathology were not performed, local invasion of the adjacent bone cannot be ruled out as a cause for the second CAA. To our knowledge, multiple CAA in the same animal have not been previously reported in the veterinary literature.

The second surprising finding was the ventral cortical bony callus that developed on a dog that underwent rim excision centered on the right mandibular first premolar and right mandibular canine tooth. We suspect that the fracture was secondary to stress riser formation between the jaw and the surgical site; however, histopathology was not employed to verify the fractures or confirm the subsequent callus formation. At the time of writing, no further treatments had been instituted, and the dog was doing well without evidence of tumor regrowth.

Limitations of this study are its retrospective nature and the inherent inability of the surgical technique to allow margin evaluation by histopathology. Initial radiographs, if obtained by the referring veterinarians, were not available for review at the time of this study. Radiographs were evaluated by the primary surgeon preoperatively to confirm appropriate case selection for rim excision. Additionally, although clients were contacted, follow-up oral examinations and dental radiographs were not performed. These follow-up procedures would have been ideal to verify the clients’ reports of functionality and lack of recurrence following rim excision.

Due to the low incidence of CAA, a large prospective multicenter study of rim excision might be undertaken to better evaluate jaw function and long-term monitoring for recurrence. Ideally, a scoring system would be created based on a large number of dogs with a variety of tumor sizes, and any local or systemic recurrence would be noted. This scoring system could guide clinicians on the use of rim excision versus mandibulectomy or maxillectomy.

Conclusion
Overall, client satisfaction with cosmesis and perception of the dog’s ability to masticate was good to excellent. No clients were dissatisfied with the appearance of their pet, and most could not tell where the surgery had been performed. Complications associated with rim excision were limited to one case in which a ventral callus was palpated at the site of surgery. No recurrence of CAA was reported. Overall, based on this small number of cases, rim excision appears to be a viable treatment option for CAA that are <2 cm and have <3 mm of bone destruction evident on radiographs. Rim excision results in improved dental occlusion and cosmesis compared to more radical excision.

References
A Retrospective Study of Factors Influencing Survival Following Surgery for Gastric Dilatation-Volvulus Syndrome in 306 Dogs

Gastric dilatation-volvulus (GDV) is a life-threatening condition in dogs that has been associated with high mortality rates in previous studies. Factors were evaluated in this study for their influence on overall and postoperative mortality in 306 confirmed cases of GDV between 2000 and 2004. The overall mortality rate was 10%, and the postoperative mortality rate was 6.1%. The factor that was associated with a significant increase in overall mortality was the presence of preoperative cardiac arrhythmias. Factors that were associated with a significant increase in postoperative mortality were postoperative cardiac arrhythmias, splenectomy, or splenectomy with partial gastric resection. The factor that was associated with a significant decrease in the overall mortality rate was time from presentation to surgery. This study documents that certain factors continue to affect the overall and postoperative mortality rates associated with GDV, but these mortality rates have decreased compared to previously reported rates. J Am Anim Hosp Assoc 2010;46:97-102.

George Mackenzie, DVM
Mathew Barnhart, DVM, Diplomate ACVS
Shawn Kennedy, DVM, Diplomate ACVS
William DeHoff, DVM, Diplomate ACVS
Eric Schertel, DVM, PhD, Diplomate ACVS

Introduction
Gastric dilatation-volvulus (GDV) is a life-threatening condition in dogs that has historically been associated with high mortality rates. Early studies reported overall mortality rates of 33% to 68%.1,2 In those studies, splenic and gastric injuries were not examined as independent factors influencing survival. More recent studies demonstrate that overall mortality rates have declined to 15%,3-5 but they remain higher when splenectomy (32%),4 partial gastrectomy (35%),4 or both (55%)4 are performed.

The influence of the duration of ischemia on tissue viability in dogs with GDV has been well documented.6,7 The duration and degree of gastric and splenic ischemia in experimental studies of GDV have been shown to directly influence organ viability.8-10 In clinical studies, the duration of signs of GDV has been thought to be directly related to increased risk of gastric and splenic injury and mortality.11-13 Based on this scientific evidence, the following techniques were recommended to improve outcomes: rapid decompression of the stomach; prompt fluid resuscitation; rapid transition to surgery for quick and efficient repositioning of the stomach and spleen; and prompt management of damaged tissues.

The primary goal of this study was to update the knowledge of overall and postoperative mortality rates and factors influencing mortality in a large number of dogs with GDV. The influences of several factors on survival, which had not been previously studied, were evaluated. We tested the hypothesis that the time from hospital presentation to surgery (i.e., the time required for diagnostic testing and stabilization) and the times required for anesthesia and surgery all directly influence both the overall
and postoperative mortality rates. We also compared the overall and postoperative mortality rates identified in this report with rates in previous studies to determine if there has been improvement.

Materials and Methods

The medical records for all dogs diagnosed with GDV from 2000 to 2004 were retrospectively evaluated. A diagnosis of GDV was based on right lateral abdominal radiographs. Only data from dogs that were anesthetized for surgery and confirmed to have GDV were included in the study.

Medical records were evaluated for the following: signalment; duration of clinical signs prior to presentation (i.e., time from when the owner noticed the dog was sick to presentation at the hospital); interval from presentation to surgery (i.e., the initiation of the skin incision); evidence of preoperative cardiac arrhythmias; duration of anesthesia; duration of surgery; splenic injury treated by splenectomy; gastric injury treated by partial gastrectomy; and postoperative cardiac arrhythmias.

Preoperative treatments, complete blood count results, and serum biochemical profile results were not evaluated in this study. Routine preoperative treatment consisted of needlegastric decompression and administration of 0.9% saline or lactated Ringer’s solution as a bolus of 60 to 90 mL/kg intravenously [IV] over the first hour, followed by 5 mL/kg per hour until the time of anesthetic induction.

Preoperative and postoperative cardiac arrhythmias were recorded when physical evidence of pulse deficits and/or electrocardiogram abnormalities were noted. A dog was considered to have intermittent ventricular arrhythmias when the heart rate was <150 beats per minute and the ventricular ectopic beats made up <50% of the beats in 1 minute. When the heart rate was >150 beats per minute and the ventricular ectopic beats made up >50% of the beats in 1 minute, the dog was considered to have ventricular tachycardia. When ventricular tachycardia was present, the dog was treated with one or more boluses of lidocaine (1 to 8 mg/kg IV), followed by a continuous-rate infusion (CRI) of lidocaine (25 to 75 µg/kg IV per minute). The lidocaine infusion was continued until arrhythmias improved, then it was slowly decreased over a 12-hour period by cutting the CRI in half every 6 hours.

A similar anesthesia protocol was used in all dogs. Premedication was a combination of hydromorphone (0.05 mg/kg IV) and diazepam (0.2 mg/kg IV). Propofol (4 to 6 mg/kg IV) was administered for induction, intubation was performed, and anesthesia was maintained with either isoflurane or sevoflurane in pure oxygen. Fluids were continued intraoperatively at a rate of 10 to 20 mL/kg per hour. Appropriate fluid rate and fluid composition were adjusted as needed based on each individual case to address areas of concern (e.g., heart rate, blood pressure). Surgery was performed by a Diplomate of the American College of Veterinary Surgeons or a surgery resident. Surgical treatment always included an exploratory laparotomy, gastric decompression by orogastric tube or needle gastrocentesis, repositioning the stomach, and incisional gastropexy. Splenectomy (using polydioxanone or chronic gut suture ligation), partial gastrectomy (sutured, one- or two-layer closure with polydioxanone suture), or both surgical procedures were performed when deemed necessary according to the following subjective criteria. Splenic viability was assessed based on color, compliance, vascular integrity, and/or response to reperfusion. Vascular integrity of the spleen was assessed based on evidence of vascular thrombi, presence of blood flow and/or a pulse in the splenic artery and veins, and evidence of hemorrhage from splenic vessels or parenchyma. Response to reperfusion was assessed by examining the changes in color, compliance, and vascular integrity once the spleen was repositioned following gastric repositioning and decompression. Assessment of gastric viability was based on serosal color, gastric wall texture, and vascular integrity. The vascular integrity of the stomach was assessed by examining blood flow in surface vessels, blanching and reperfusion with digital pressure, and bleeding at the cut edge in cases of resection. Extensive gastric injury was considered to have occurred when it appeared that >60% of the stomach was irreversibly damaged and the cardia region was extensively involved.

Postoperatively, dogs were maintained on crystalloid fluid therapy at a rate of 2 to 4 mL/kg per hour, and pain management was based on doctor preference and included either hydromorphone (0.05 mg/kg as needed) or fentanyl (2.5 to 5 µg/kg per hour). Types of postoperative fluids and pain management medications were not evaluated for effect on postoperative mortality.

The overall mortality rate was defined as the ratio of the number of dogs that died or were euthanized either intraoperatively or postoperatively to all dogs that were anesthetized for surgery. The postoperative mortality rate was defined as the ratio of dogs that died or were euthanized during the postoperative period to all dogs that survived anesthesia. The postoperative period was defined as the time from the end of anesthesia to hospital discharge.

A statistical consulting service and software package were used to evaluate data. Logistic regression models were used to evaluate the effects of breed, sex, age, and the presence of any cardiac arrhythmia on postoperative mortality. Logistic regression models were also used to evaluate the effects of duration of clinical signs, interval until surgery, anesthesia time, surgery time, and type of surgery performed (e.g., incisional gastropexy alone, incisional gastropexy with splenectomy or incisional gastropexy with partial gastrectomy, or an incisional gastropexy with both splenectomy and partial gastrectomy) on postoperative mortality rate. Hosmer-Lemeshow goodness-of-fit tests were performed for evaluating the logistic regressions. The overall and postoperative mortality rates of the dogs in this study were compared with the more recent studies by Brockman et al. and Bruerman et al., in which a one-sided binomial proportion test was used when the data were presented in a fashion allowing clear comparison. The lesser percentage between the two studies was used when comparing for significance. Findings were considered significant when $P<0.05$. 
Results

Of the dogs diagnosed with GDV between 2000 and 2004, 306 met the inclusion criteria for the study. The overall mortality rate was 10% (30 of 306 dogs), and the postoperative mortality rate was 6.1% (18 of 294 dogs), as illustrated in Figure 1. Of the 30 dogs that died or were euthanized, 12 died intraoperatively. Four of the 12 died spontaneously, and the other eight were euthanized intraoperatively based on the surgeon’s assessment of extensive gastric damage.

Thirty-eight breeds were represented in this study. The most common breeds included German shepherd dogs (n=40, 13.1%), Great Danes (n=30, 9.8%), standard poodles (n=24, 7.8%), Labrador retrievers (n=19, 6.2%), large mixed-breed dogs (n=18, 5.9%), golden retrievers (n=17, 5.6%), Akitas (n=17, 5.6%), Doberman pinschers (n=14, 4.6%), and chow chows (n=13, 4.2%). Breed did not affect the overall mortality rate in this study (P=0.168). In addition, age and sex did not significantly affect the overall mortality (P=0.339 and P=0.447, respectively), as described in Table 1. The mean age of dogs was 8±3.54 years (range 7 months to 16 years). One hundred twenty-three (40%) dogs were neutered males, 99 (32.7%) were spayed females, 58 (19.0%) were intact males, and 25 (8.2%) were intact females.

The mean duration of clinical signs was 7.4±3.44 hours (range 2 to 12 hours, median 6 hours). As shown in Table 1, duration of clinical signs did not affect overall mortality (P=0.417). The mean time from presentation to surgery was 75±26.6 minutes (range 15 to 300 minutes; median 60 minutes). A significant inverse relationship was found between time from presentation to surgery and the overall mortality rate (P=0.035; odds ratio 0.93; 95% confidence interval 0.86 to 0.99). In other words, an increased time from presentation to surgery was associated with a lower overall mortality rate.

The only arrhythmias recorded in this cohort of dogs were of ventricular origin. Preoperative cardiac arrhythmias were recorded in 11% (16 of 147) of dogs presented for GDV. Twelve dogs had intermittent ventricular arrhythmias, and four dogs had ventricular tachycardia. Of the dogs with preoperative intermittent ventricular arrhythmias, four died. No deaths occurred in dogs diagnosed with preoperative ventricular tachycardia. Preoperative intermittent ventricular arrhythmia was associated with a significantly higher overall mortality rate (P=0.035), but preoperative ventricular tachycardia was not associated with an increased overall mortality rate (P=0.088). Forty-eight percent of dogs with preoperative cardiac arrhythmias subsequently underwent splenectomy and/or partial gastrectomy, whereas only 27% of dogs without preoperative cardiac arrhythmias required splenectomy and/or partial gastrectomy; however, this difference was not significant (P=0.056).

Postoperative cardiac arrhythmias were present in 133 of 172 dogs. Of these 133 dogs, 105 had intermittent ventricular arrhythmias and 28 had ventricular tachycardia. Postoperatively, one of the dogs with intermittent ventricular arrhythmias died (P=0.47), and four of the dogs with ventricular tachycardia died (P=0.035), suggesting that postoperative ventricular tachycardia was associated with an increased postoperative mortality rate [Table 1].

The mean duration of anesthesia and mean duration of surgery were 67±20.44 minutes (range 20 to 240 minutes; median 60 minutes) and 48±30 minutes (range 20 to 240 minutes; median 30 minutes), respectively. No association was seen between the length of time for either parameter and postoperative mortality rate [Table 1].

Incisional gastropexy was performed in all 294 dogs that survived surgery. Dogs that had gastropexy alone (n=212) had a postoperative mortality rate of 3% (n=6). Splenectomy was performed in 61 (21%) of the 294 dogs. Dogs in which splenectomy was the only additional surgical procedure performed (34 of 61 dogs) had a significantly
higher postoperative mortality rate (15%; \( P=0.008 \)) than dogs that did not require splenectomy. Partial gastrectomy was performed in 58 (20%) of 294 dogs. The postoperative mortality rate (9%; \( P=0.496 \)) for dogs in which partial gastrectomy was the only additional surgical procedure performed (n=23) was not significantly higher than the rate for dogs that did not have a partial gastrectomy. Dogs that had both splenectomy and partial gastrectomy (n=25) had a significantly higher (\( P<0.0001 \)) postoperative mortality rate of 20% compared to dogs that did not have both splenectomy and partial gastrectomy [Figure 1].

The overall mortality rate of 10% cited in this present study was significantly lower than the overall mortality rates from the data reported in recent previous studies [Table 2].

### Discussion

The overall mortality rate (10%) for the 306 dogs taken to surgery during the 5-year period was improved compared to the overall mortality rates reported in the more recent studies by Brockman et al\(^3\) (15%, \( P=0.001 \)), Beck et al\(^5\) (16%), and Brouerman et al\(^4\) (18%). Consistent with previous reports, this study found that preoperative cardiac arrhythmias were associated with a higher overall mortality rate, and splenectomy and splenectomy combined with partial gastrectomy were associated with higher postoperative mortality rates. Factors such as breed, age, sex, duration of clinical signs, and partial gastrectomy alone were not associated with increased mortality rates. The breeds treated in this present study are consistent with breeds described previously.\(^{15}\)

Gastric necrosis, splenic injury, or both—treated by partial gastrectomy and/or splenectomy—have historically been associated with postoperative mortality rates ranging from 30% to 68%.\(^{3,4,13,16}\) The postoperative mortality rates in this present study for partial gastrectomy (9%), splenectomy (15%), and both splenectomy and partial gastrectomy (20%) are significantly lower than those reported by Brouerman et al\(^4\) and Brockman et al,\(^3\) where the postoperative mortality rates were never <31% for these conditions [Table 2].

In this study, an increased time from presentation to surgery was associated with a lower mortality rate. This relationship was an unexpected finding, as it is widely accepted.

### Table 1

Logistic Regression Analysis Evaluating the 422 Relationships of Factors Influencing Postoperative Mortality From Gastric Dilatation-Volvulus

<table>
<thead>
<tr>
<th>Predictor*</th>
<th>Coefficient</th>
<th>Standard Error of the Coefficient</th>
<th>Z Value</th>
<th>P Value</th>
<th>Odds Ratio</th>
<th>Confidence Interval (Lower)</th>
<th>Confidence Interval (Upper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.0218992</td>
<td>0.08419</td>
<td>0.26</td>
<td>0.795</td>
<td>1.02</td>
<td>0.87</td>
<td>1.21</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.555562</td>
<td>0.60116</td>
<td>-0.92</td>
<td>0.355</td>
<td>0.57</td>
<td>0.18</td>
<td>1.86</td>
</tr>
<tr>
<td>PIA</td>
<td>1.28785</td>
<td>0.6092</td>
<td>2.11</td>
<td>0.035</td>
<td>3.63</td>
<td>1.1</td>
<td>11.96</td>
</tr>
<tr>
<td>PRVT</td>
<td>1.28485</td>
<td>0.7557</td>
<td>1.70</td>
<td>0.088</td>
<td>3.63</td>
<td>0.82</td>
<td>15.94</td>
</tr>
<tr>
<td>PIVA</td>
<td>0.068177</td>
<td>0.380836</td>
<td>0.73</td>
<td>0.47</td>
<td>0.99</td>
<td>0.857</td>
<td>0.962</td>
</tr>
<tr>
<td>PVT</td>
<td>1.935807</td>
<td>0.095508</td>
<td>-1.8</td>
<td>0.035</td>
<td>0.14</td>
<td>0.4524</td>
<td>9.357</td>
</tr>
<tr>
<td>SPX</td>
<td>5.5121</td>
<td>2.9258</td>
<td>2.63</td>
<td>0.008</td>
<td>247.67</td>
<td>4.1</td>
<td>14966.1</td>
</tr>
<tr>
<td>GX</td>
<td>-1.17279</td>
<td>1.7226</td>
<td>-0.68</td>
<td>0.496</td>
<td>0.31</td>
<td>0.01</td>
<td>9.06</td>
</tr>
<tr>
<td>SPX/GX</td>
<td>1.7957</td>
<td>0.41485</td>
<td>-4.33</td>
<td>0.0001</td>
<td>0.17</td>
<td>0.031</td>
<td>0.369</td>
</tr>
<tr>
<td>DCS</td>
<td>-0.145567</td>
<td>0.17944</td>
<td>-0.81</td>
<td>0.417</td>
<td>0.86</td>
<td>0.61</td>
<td>1.23</td>
</tr>
<tr>
<td>TTS</td>
<td>-0.077802</td>
<td>0.03691</td>
<td>-2.11</td>
<td>0.035</td>
<td>0.93</td>
<td>0.86</td>
<td>0.99</td>
</tr>
<tr>
<td>AT</td>
<td>-0.293736</td>
<td>0.08653</td>
<td>-0.34</td>
<td>0.734</td>
<td>0.97</td>
<td>0.82</td>
<td>1.15</td>
</tr>
<tr>
<td>ST</td>
<td>-0.006183</td>
<td>0.09167</td>
<td>-0.07</td>
<td>0.946</td>
<td>0.99</td>
<td>0.83</td>
<td>1.19</td>
</tr>
</tbody>
</table>

* PIA=preoperative intermittent ventricular arrhythmias; PRVT=preoperative ventricular tachycardia; PIVA=postoperative intermittent ventricular arrhythmias; PVT=postoperative ventricular tachycardia; SPX=splenectomy; GX=partial gastrectomy; DCS=duration of clinical signs; TTS=time from presentation to surgery; AT=anesthetic time; ST=surgery time
The postoperative mortality rate was higher for dogs treated with splenectomy than the rate for dogs treated with partial gastrectomy or incisional gastropexy alone. Recent reports evaluated both radiographic findings and serological data as predictors of gastric necrosis.\textsuperscript{17-19} The identified higher postoperative mortality rates in this report suggest that development of serum biochemical or other markers of splenic damage may be useful in predicting overall mortality in dogs with GDV.

Because of the retrospective nature of this study, full characterization of the cardiac arrhythmias was not possible. Brouerman \textit{et al}\textsuperscript{4} reported a significantly increased overall mortality rate (38\%) when preoperative cardiac arrhythmias were detected, and Brockman \textit{et al}\textsuperscript{3} reported no significant effect of cardiac arrhythmias on postoperative mortality rate. Consistent with the study by Brouerman \textit{et al},\textsuperscript{4} the 11\% of dogs in our study with preoperative cardiac arrhythmias had a significantly higher overall mortality rate than dogs without a preoperative cardiac arrhythmia. Interestingly, preoperative intermittent ventricular arrhythmias were associated with a significantly higher overall mortality rate, whereas ventricular tachycardia (usually considered a more serious condition) was not. Postoperative intermittent ventricular arrhythmias were not shown to significantly affect postoperative mortality, but postoperative ventricular tachycardia compared to no arrhythmia and intermittent arrhythmia (combined) did result in a significant increase in postoperative mortality.

The significance and treatment of cardiac arrhythmias in dogs with GDV have been controversial subjects.\textsuperscript{1,3-5} Guidelines regarding the point at which treatment should be initiated and the method of treatment for ventricular arrhythmias were established 15 years ago based on consultations with a cardiologist. The established guidelines do not take into account multifocal ectopia or the R-on-T phenomenon that might also indicate a need for treatment.

A statistical limitation in this report involved the low number of overall and postoperative mortality rates. The bottom line is that mortality rates were low in this report, so larger sample sizes would be required to better perform statistical tests comparing mortality rates among groups. The other limitations of this study relate to its retrospective nature and the fact that the records were not complete enough to fully evaluate all parameters of therapy. What we can say is that management of GDV cases is very standardized in our clinic with regard to fluid therapy and pain management, and it reflects what was previously described in the Materials and Methods section. We understand that preoperative, intraoperative, and postoperative management of a dog with GDV can greatly influence survival, and further investigation into these areas is needed.

\textbf{Conclusion}

The 10\% overall mortality rate for dogs with GDV is significantly better than rates reported in recent studies. The postoperative mortality rates for dogs having splenectomy and partial gastrectomy were also lower than rates in previous

\begin{table}[h]
\centering
\caption{Comparison of Mortality Rates to Data From Two Previously Published Studies}
\begin{tabular}{|l|c|c|c|}
\hline
Mortality Rates & Current Study & Brockman, \textit{et al}, Study & Brouerman, \textit{et al}, Study \\
\hline
OMR & 10\% & 15\%\textsuperscript{†} & 18\% \\
PMR/GX & 9\% & 31\%\textsuperscript{†} & 35\% \\
PMR/SX & 15\% & NA\textsuperscript{‡} & 32\%\textsuperscript{†} \textsuperscript{,} P=0.019 \\
PMR/SGX & 20\% & NA & 50\%\textsuperscript{†} \textsuperscript{,} P=0.000 \\
\hline
\end{tabular}
\begin{flushleft}
\textsuperscript{†} P<0.05 \\
\textsuperscript{‡} NA=data not available \\
\textsuperscript{*} OMR=overall mortality rate; PMR=postoperative mortality rate; GX=partial gastrectomy; SX=splenectomy; SGX=splenectomy and partial gastrectomy \\
\end{flushleft}
\end{table}
reports. Splenic and gastric damage continues to be associ-
ated with higher postoperative mortality rates, with splenecto-
my having the greatest influence on postoperative mortality
rate. Consistent with some previous studies, preoperative and
postoperative cardiac arrhythmias were found to be associ-
ated with significantly increased overall and postoperative
mortality rates. The hypothesis that time from hospital pre-
sentation to surgery and the duration of anesthesia and sur-
gery directly affect overall mortality rates was not supported
by the data included in this study. Instead, the time from
presentation to surgery was inversely associated with the
overall mortality rate. The fact that the anesthesia times were
less than half of those previously reported may suggest that
anesthesia and surgery times play a role in improved sur-
vival. Further research is warranted. In the meantime, these
results should not be over interpreted: GDV cases should be
treated surgically as soon as reasonably possible.

Footnotes

a Hydromorphone; Baxter Healthcare Corporation, Deerfield, IL 60015
b Diazepam; Hospira, Inc., Lake Forest, IL 60045
c Propofol; Abbott Laboratories, North Chicago, IL 60064
d Isoflurane; VetOne
e Sevoflurane; Abbott Laboratories, North Chicago, IL 60064
f Chromic gut suture; Ethicon, Inc., Raleigh, NC 27601
g Ohio State University Statistical Consulting Service, Columbus, OH
h Fentanyl; Baxter Healthcare Corporation, Deerfield, IL 60015
i Minitab, Inc., State College, PA 16801

References

1. Muir WW. Gastric dilatation-volvulus in the dog, with emphasis on
2. Pass M, Johnston D. Treatment of gastric dilatation and torsion in
the dog: Gastric decompression by gastrotomy under local analgesia.
3. Brockman DJ, Washabau RJ, Drobatz KJ. Canine gastric dilata-
tion-volvulus syndrome in a veterinary critical care unit: 295 cases
perioperative mortality in dogs with surgically managed gastric
1996;208:1855-1858.
short-term outcome and development of perioperative complications
in dogs undergoing surgery because of gastric dilatation-volvulus:
6. Horne WA, Gilmore DR, Dietze AE, et al. Effects of gastric disten-
tion-volvulus on coronary blood flow and myocardial oxygen con-
7. Badyak SF, Lantz GC, Jeffries M. Prevention of reperfusion injury in
surgically induced gastric dilatation-volvulus in dogs. Am J Vet Res
8. Pfeiffer CJ, Keith IC, April M. Topographic localization of gastric
lesions and key role of plasma bicarbonate concentration in dogs
with experimentally induced gastric dilatation. Am J Vet Res
9. Matthiesen DT. The gastric dilatation-volvulus complex: medical and
10. Orton EC, Muir WW. Hemodynamics during experimental gastric
of survival and recurrence following the acute gastric dilatation-volv-
13. Broome CJ, Walsh VP. Gastric dilatation-volvulus in dogs. New
14. Frendin J, Funkquist B. Fundic gastropexy for the prevention of
15. Glickman LT, Glickman NW, Shellenberg DB, et al. Incidence of
and breed related risk factors for gastric dilatation-volvulus in dogs.
16. Winfield WE, Betts CW, Greene RW. Operative techniques and
recurrence rates associated with gastric volvulus in the dog. J Small
17. Papp E, Drobatz KJ, Hughes D. Plasma lactate concentration as a
predictor of gastric necrosis and survival among dogs with gastric
18. Fischetti AJ, Saunders HM, Drobatz KJ. Pneumatosis in canine gas-
tric dilatation-volvulus syndrome. Vet Rad and Ultrasound
2004;45:205-209.
19. Millis DL., Hauptman JG, Fulton RB. Abnormal hemostatic profiles
and gastric necrosis in canine gastric dilatation-volvulus. Vet Surg
Primary Prostatic Leiomyosarcoma With Pulmonary Metastases in a Dog

A 6-year-old, intact male Jack Russell terrier was diagnosed with a mass in the caudal abdomen, and ultrasound revealed a large prostatic mass. A total-body computed tomography scan was performed for staging, and lung nodules were detected. Histological examination showed a proliferation of spindle cells arranged in interlacing fascicles. Immunohistochemical staining revealed cells were cytokeratin negative and immunoreactive for vimentin and α-smooth muscle actin; cells stained with desmin and S-100 were negative. A diagnosis of primary prostatic leiomyosarcoma with pulmonary metastases was made. This is one of the rare cases of primary prostatic mesenchymal tumor in the canine species.


Introduction

Primary neoplasms of the prostate gland are uncommon in canine species and mostly arise from the glandular epithelium, with adenocarcinoma being the most frequently diagnosed tumor type. Sarcomas of the prostate are extremely rare in humans and animals. In humans, prostatic sarcoma represents <0.1% of all malignant tumors. In the dog, a single case of prostatic leiomyosarcoma and two cases of hemangiosarcoma have been documented. Prostatic diseases are most common in old, intact male dogs, and a progressive increase in the incidence of prostatic abnormalities is associated with advanced age. In this report, a case of primary prostatic leiomyosarcoma is described.

Case Report

A 6-year-old, intact male Jack Russell terrier with a 6-month history of stranguria and dyschezia was presented for a second opinion. Four months prior to the clinical examination, the dog was treated elsewhere for prostatic cysts by multiple sessions of drainage and alcoholization of the cystic cavities. Physical examination revealed a distended urinary bladder and a palpable mass in the caudal abdomen.

A complete blood count, serum biochemical profile, and urinalysis were normal. Ultrasound of the abdomen with an 8-MHz microconvex probe revealed a large, heterogenous mass in the prostate. A hyperechoic area was surrounded by a hypoechoic band in the cranioventral part of the prostate [Figure 1]. Two large cysts were also present. Power Doppler was performed to assess vascularity of the tumor. Vascularity in the hyperechoic area was revealed, while no vessels were detected in the hypoechoic peripheric tissue. An ultrasound contrast study was performed using a second-generation contrast medium (0.03 mL/kg) with a linear 7.5-MHz probe. A cranioventral area about 3 cm in diameter was always hypoechoic (during the wash-in, peak, and wash-out phases) compared to the surrounding tissues. Only a large feeding vessel was detected in that area.

The dog was anesthetized with intravenous diazepam and propofol and maintained with isoflurane. A helical total-body computed tomography (CT) scan was performed for staging of the possible neoplasia. The
dog was placed in dorsal recumbency, and CT imaging was done with 120 kV and 160 mA for 1 second using 5-mm slice thickness and pitch 1. Computed tomography images were made before and after the manual intravenous injection (800 mg/kg) of nonionic iodinated contrast medium. Computed tomography revealed a large, heterogenous, and irregularly shaped prostate with two large cysts occupying the pelvic area [Figure 2]. The contrast enhancement of the prostate was markedly heterogenous, with no contrast in the two cystic lesions; the contrast enhancement of the prostatic mass was mild. Several round nodules, consistent with metastases, were seen in the lungs [Figure 3]. Ultrasound-guided Tru-Cut biopsy of the prostatic mass was performed with a 16-gauge spring-loaded needle. Histological examination of the biopsy revealed a poorly differentiated, neoplastic malignant spindle cell lesion of uncertain origin.

Because of a poor prognosis, the dog was euthanized. At necropsy, the prostate gland was completely replaced by a 7-cm diameter, poorly demarcated, whitish, firm mass. Transverse section of the prostate revealed a firm tissue with large, cystic, fluid-filled cavities. The tumor completely encircled the urethra, and the urinary bladder was distended and had a markedly thickened wall. Multiple, randomly distributed, 0.5-cm, white nodules were observed in the lungs.

Tissues for light microscopy were fixed in 10% neutral-buffered formalin, embedded in paraffin, sectioned (4 µm thick), and stained with hematoxylin and eosin. Other sections were prepared for immunohistochemical analysis using an avidin-biotin complex method. Antibodies used were the following: cytokeratin AE1/AE3 (1:100 dilution, monoclonal), vimentin (1:100 dilution, monoclonal), α-smooth muscle actin (α-SMA), clone 1A4 (1:100 dilution, monoclonal), desmin (1:100 dilution, monoclonal), and S-100 (1:200 dilution). Citric acid buffer-based microwave antigen retrieval was performed. Diaminobenzidine was used as chromogen. Finally, the slides were counterstained with Papanicolaou hematoxylin, dehydrated, and mounted.
under DPX. The positive controls for each run consisted of one section from a tissue known to express the antigen being investigated. As a negative control for nonspecific binding, the primary antibody was replaced with an irrelevant, isotype-matched antibody.

Histopathological evaluation was performed on the prostate mass removed at necropsy. The prostate gland was expanded by an unencapsulated, poorly demarcated, infiltrative, highly cellular neoplasm composed of interlacing streams and bundles of neoplastic spindle cells within an abundantly extracellular, collagenous matrix. Neoplastic cells had indistinct cell borders and a moderate amount of eosinophilic cytoplasm frequently containing numerous, distinct, clear vacuoles. Nuclei were centrally located and elongated, with margined chromatin and one to four distinct nucleoli. Marked anisocytosis and anisokaryosis were present. Mitotic figures were 15 per 10 high-power field (40x objective) [Figure 4]. Multiple foci of necrosis and small, multifocal areas of hemorrhage with a few hemosiderin-laden macrophages were present. Moreover, within the neoplasm, multiple follicular inflammatory foci (mostly composed of lymphocytes and lesser numbers of plasma cells and macrophages) were also visible. Occasionally spared, normal prostate gland that had become trapped in the tumor was visible. A diagnosis of high-grade (III) sarcoma was made based on a modified human grading system previously described by Kuntz et al.8 The lung nodules observed on gross postmortem examination had similar histology to the primary tumor and were located primarily within blood vessels.

Immunohistochemical analysis was performed for further characterization of the neoplasm. Cytoplasm from the majority of neoplastic cells stained intensely positive for vimentin [Figure 5A]. Alpha-smooth muscle actin displayed strong cytoplasmic positive staining in approximately 50% of tumor cells [Figure 5B]. Cytokeratin, desmin, and S-100 were not detected. A diagnosis of primary prostatic leiomyosarcoma was made based on positive staining for vimentin and α-SMA. Immunohistochemical analysis was not done on the histologically similar lung lesions.

**Discussion**

A diagnosis of high-grade primary leiomyosarcoma with pulmonary metastases was made on the basis of spindle cell morphology, arrangement of tumor cells, positive staining of neoplastic cells for vimentin and α-SMA, and exclusion of other spindle cell tumors by negative results to a spectrum of immunohistochemical stains. The differential diagnoses for malignant spindle cell tumors of prostatic gland include fibrosarcoma, leiomyosarcoma, hemangiosarcoma, sarcomatoid carcinoma, malignant peripheral nerve sheath tumor (MPNST), liposarcoma, and myxosarcoma. Differentiating between these tumor types can sometimes be difficult.
Immunohistochemical analysis is helpful for the correct classification of mesenchymal tumors. In the present case, the mesenchymal origin of tumor cells was supported by strong cytoplasmic positivity to vimentin. Vimentin is a cytoplasmic intermediate filament that is expressed by a wide variety of mesenchymal tumors. The reaction to α-SMA and negative staining to desmin supported the diagnosis of leiomyosarcoma. Alpha-SMA and desmin are cytosolic intermediate filaments specific to smooth muscle cells and to skeletal muscle cells, respectively. Both are used in human and veterinary pathology to differentiate smooth and skeletal muscle tumors. Actin has been demonstrated in different types of tumors that display myofibroblastic differentiation. The actin antibody used in the present case (clone 1A4), however, specifically identifies actin isoforms found in smooth muscle. Moreover, negative staining for cytokinin excluded the possibility of sarcomatoid carcinoma, and negative staining for S-100 excluded MPNST.

Prostatic sarcomas may arise from the mesenchymal stroma of the prostate, and the positivity to α-SMA may suggest an origin from the myofibroblastic stromal component. Some authors suggest that fibromuscular hyperplasia may give rise to both fibrosarcomas and leiomyosarcomas. In the case described here, the intimate relationship of the mass to the prostate, coupled with the histological appearance, supported an origin from the prostatic stromal tissue.

Diagnostic imaging is useful for the evaluation of the local extension of the tumor and the presence of distant metastases. Power Doppler and contrast ultrasound were performed to assess the vascularity and the perfusion of the mass, respectively; however, the findings were nonspecific. In the different phases of the tissue perfusion, contrast-enhanced ultrasound showed hypoechoogenicity of the mass compared to surrounding tissue. In a recent study performed in splenic lesions, all malignancies showed different perfusion patterns compared to the surrounding parenchyma. After a variable wash-in phase, malignant tumors are hypoperfused in a wash-out phase. In contrast, benign lesions are characterized by similar perfusion to the adjacent parenchyma, so lesions are isoechoic at the peak and wash-out phases and no longer recognizable from the normal parenchyma. In the present case, the prostatic mass was always hypoechoic (during the wash-in, peak, and wash-out phases) compared to the surrounding tissue, similar to sarcomas described in the spleen.

Computed tomography is extremely useful for tumor staging, and in this case it allowed better evaluation of the extent of the lesion than ultrasound. Moreover, CT is more sensitive in examining for lung metastases than conventional radiology. Metastases of prostatic tumors are common in dogs and humans. The cases described in the literature of canine prostatic leiomyosarcoma and hemangiosarcoma metastasized to the lung; the course of these cases suggests that the prognosis for prostatic sarcomas can be very poor. In the present case, the tumor emboli within the vascular and lymphatic lumina of the pulmonary tissue was indicative of the cancer's routes of metastasis.

**Conclusion**

This is a rare case of primary leiomyosarcoma of the prostate with pulmonary metastases in a dog.

**Footnotes**

a My-lab 30; Esato, 50100 Firenze, Italy  
 b Sonovue; Bracco, 20100 Milano, Italy  
 c Pro-speed Power; General Electric, 20100 Milano, Italy  
 d Xenetix; Guerbet, 16100 Genova, Italy  
 e Cytokeratin AE1/AE3; Dako, 2600 Glostrup, Denmark  
 f Vimentin; Daco, 2600 Glostrup, Denmark  
 g Alpha-smooth muscle actin; Daco, 2600 Glostrup, Denmark  
 h Desmin; Daco, 2600 Glostrup, Denmark  
 i S-100; Daco, 2600 Glostrup, Denmark  
 j DAB; Sigma Chemical Company, St. Louis, MO 63108  
 k DPX, Fluka, Sigma-Aldrich Chemie GmbH, 9471 Buchs, Switzerland

**References**

Multiple Follicular Cysts of the Ear Canal in a Dog

An 11-year-old, 18-kg, neutered male standard schnauzer was presented for evaluation of recurrent otitis externa with para-aural swelling and fistulation of the right external ear canal of 6 months' duration. Otoscopic examination was impossible because of the severe stenosis of the ear canal. Right para-aural ultrasound examination and ultrasound-guided fine-needle aspiration of a mass-like lesion were performed. Cytology was suggestive of a follicular cyst. Magnetic resonance imaging revealed severe ear canal stenosis with a heterogeneous mass in the horizontal portion of the ear canal and associated otitis media. Total ear canal ablation with lateral bulla osteotomy was performed. Histopathological diagnosis was chronic otitis externa associated with multiple follicular cysts confined to the ear canal. Surgical treatment proved curative. This is the first report of multiple follicular cysts originating from the ear canal in a dog. J Am Anim Hosp Assoc 2010;46:107-114.

Matthew Gatineau, DVM
Bertrand Lussier, DVM, MS, Diplomate ACVS
Kate Alexander, DVM, MS, Diplomate ACVR

Introduction
Follicular cysts, epidermal inclusion cysts, epidermal cysts, epidermoid cysts, and infundibular cysts are responsible for 33% and 50% of the non-neoplastic, noninflammatory, tumor-like lesions removed from dogs and cats, respectively. Follicular cysts occur most frequently in middle-aged to older dogs, and they often are located on the dorsum and extremities.

To the authors' knowledge, follicular cysts originating from the external ear canal have not been reported in dogs. The purpose of this report is to describe the presentation, diagnostic workup, surgical treatment, and outcome of recurrent otitis externa and media secondary to multiple aural follicular cysts in a dog.

Case Report
An 11-year-old, 18-kg, neutered male standard schnauzer was referred to our institution for chronic otitis externa and para-aural swelling and fistulation of the right ear. Six months prior to referral to us, the dog was presented to the referring veterinarian for swelling at the base of the right ear. At that time, the dog was treated with amoxicillin/clavulanic acid at 22 mg/kg orally q 12 hours for 1 month, and the swelling temporarily resolved. Swelling recurred and was obvious at the time of reevaluation by the referring veterinarian 2 months after the initial examination.

Skull radiographs were performed by the referring veterinarian, and they revealed a small (2 cm) mass at the base of the right ear. The mass was aspirated, and a tentative diagnosis of an abscess was made. The mass was explored, opened, and drained; samples were submitted for bacteriological evaluation. Aerobic culture revealed Staphylococcus intermedius sensitive to amoxicillin/clavulanic acid and enrofloxacin, which were administered at 22 mg/kg and 2.5 mg/kg, respectively, orally q 12 hours for 1 month. The swelling temporarily resolved. Two months after discontinuation of antimicrobial therapy, swelling reappeared in addition to a ventral para-aural fistula. The referring veterinarian obtained a biopsy at that time, which showed chronic active cellulitis.
Staphylococcus intermedius and Corynebacterium spp. were isolated, and the dog was prescribed cephalaxin (20 mg/kg orally q 8 hours for 2 months). No improvement in clinical signs was noted, and the dog was referred.

Upon presentation to the dermatology service, physical examination revealed severe stenosis of the horizontal portion of the right ear canal and a small (3 cm), firm, subauricular mass located at the base of the right ear. A para-aural fistula and purulent discharge were also present at the right ear base. Otoscopy of the left ear canal and tympanic membrane was unremarkable, but otoscopic examination of the right ear canal was impossible to perform because of the severe stenosis of the horizontal portion of the ear canal. The right submandibular lymph node was moderately increased in size. The complete blood count and serum biochemical profile were within normal limits.

Upon reviewing the skull radiographs forwarded from the referring veterinarian, a small (2 cm) mass at the base of the right ear was observed. Dystrophic mineralization of the horizontal and vertical right ear canal was seen, as well as mild to moderate thickening of the right tympanic bulla (bulla osteitis). Ultrasound (using a 5- to 8-MHz broadband-width sector probe and ultrasound machine) of the right para-aural region was performed in an attempt to define the origin and extent of the subauricular mass, to eliminate the possibility of a foreign body, and to obtain samples for cytological evaluation. Ultrasound examination revealed that the mass was well defined and represented a severe focal dilatation of the horizontal ear canal (2.4 cm, approximately four times the diameter of the left ear canal), which contained heterogeneous and highly hyperechoic material with acoustic shadowing [Figures 1A-1C]. Hyperechoic interfaces with acoustic shadowing were seen within the wall of the ear canal, representing dystrophic mineralization. Ultrasound-guided fine-needle aspiration was performed, and cytological evaluation of the ear canal material was compatible with a keratin-producing cyst or tumor in combination with a secondary infection.

To further determine the extent of the disease and to plan surgical treatment, magnetic resonance imaging (MRI) was performed under general anesthesia with a 1.5 Tesla superconducting magnet and dedicated head coil. The following image sequences were obtained: transverse pre- and post-contrast (gadobenate dimeglumine, 0.1 mmol/kg intravenously [IV]), fast-spin echo (FSE), T1-weighted (w), FSE-T2w, FSE-T2w with fat saturation (FS), fluid-attenuated inversion recovery (FLAIR), gradient recalled echo (GRE-MERGE), dorsal FSE-T2w with FS, postcontrast FSE-T1w, and sagittal FSE-T2w [Figures 2A-2C, 3A-3D].

Examination of the MRI scans revealed severe dilatation of the horizontal portion of the right ear canal. Within the focal dilatation was heterogeneous material with mixed signal intensity (predominantly T2w and FLAIR hyperintensity, intermediate granular T1w intensity, and signal suppression during fat-suppression sequences) and no contrast enhancement. No evidence of magnetic susceptibility on the gradient echo sequence was seen, indicating that the material within the focal dilatation did not have a hemorrhagic or mineralized component. An abnormal tissue extended into the right tympanic bulla and epitympanic recess, where the signal became more homogeneous and was hyperintense on T1w and T2w images without signal suppression during fat suppression. Moderate heterogeneous enhancement of this tissue was seen. A well-defined, 3 mm-diameter, cutaneous fistula extended from the ventrolateral portion of the right ear canal to the cutaneous surface. The walls of this fistula were hyperintense on T2w.
images and enhanced intensely. The ear canal walls and those of the fistula had the same signal characteristics. The dorsolateral aspects of the horizontal portion of the ear canal and the entire vertical portion of the ear canal were difficult to identify on MRI because of the severe stenosis of the canal. The ipsilateral medial retropharyngeal lymph node was also enlarged.

Based on the collective diagnostic test results, the dog was diagnosed with retention of sebaceous or ceruminous material, para-aural fistulation, and otitis media and externa. All conditions were secondary to severe ear canal stenosis. A total ear canal ablation with lateral bulla osteotomy (TECA-LBO) was recommended and authorized by the owners. The TECA-LBO of the right external ear canal was performed under general anesthesia as previously described, with two modifications: (a) an elliptical skin incision was made around the vertical portion of the ear canal orifice, including the fistula orifice, and (b) fistula identification was facilitated by catheterization, which further confirmed communication of the cutaneous fistula with the vertical ear canal. Only one complication was encountered during surgery: the facial nerve was tightly adhered to the ventral portion of the horizontal canal, and it had to be dissected and retracted to permit completion of the TECA. After copious lavage with 0.9% saline, the surgical site was primarily sutured. Primary closure with a simple interrupted suture pattern using 3-0 polydioxanone was performed to decrease the amount of dead space. A continuous intradermal suture pattern using 4-0 polyglecaprone 25 was then used, and the skin incision was closed in a “T” pattern with a simple interrupted suture of 3-0 nylon [Figures 4A, 4B].

The excised tissues (i.e., the external ear canal including the fistula and epithelial biopsies from the tympanic bulla) were submitted for histologic examination and a bacterial culture. Histopathology results revealed a chronic otitis externa and media with marked fibrosis and multiple follicular cysts. An expansive mass was visualized, which was partially bordered by keratinized epithelial cells that were multifocally acanthotic and necrotic with mild orthokeratosis [Figures 5A, 5B]. A population of neutrophils, macrophages, lymphocytes, and plasmocytes were multifocally infiltrating the dermis. Several distended hair follicles with keratin inclusions, adipocytes, and fibrous tissue constituted the mass, which also contained several distended ceruminous glands with granular acidophilic material. Mineralizations were also visualized along the squamous cells and cellular debris. Orthokeratosis and infiltration of neutrophils and macrophages extending to the tympanic bulla with necrotic cells and cellular debris were also present. *Staphylococcus intermedius* and *Enterococcus* spp. were isolated; both were susceptible to amoxicillin/clavulanic acid.

Postoperative care consisted of applying a loose, padded head bandage to cover the surgical site for 2 days. Because bandages may reduce pharyngeal airway size and thereby cause suffocation in the early postoperative period, respiration was closely monitored for the first 24 hours.
postsurgically. An Elizabethan collar was used to reduce self-mutilation until the sutures were removed (at 14 days). During bandage changes, the wound was examined for evidence of fluid accumulation or signs of infection. The dog received a continuous IV infusion of fentanyl (5 µg/kg per hour) postoperatively for 24 hours, hydromorphone hydrochloride (0.05 mg/kg IV q 4 hours) for 24 hours, and then meloxicam (0.1 mg/kg orally q 24 hours for 5 days). Antibiotic therapy using cephalaxin (20 mg/kg orally q 8 hours) was administered for the 3 days following the surgery while bacteriological results were pending. Antibiotic therapy was then changed to amoxicillin/clavulanic acid (22 mg/kg orally q 12 hours for 3 weeks) based on the bacteriological culture results and antimicrobial susceptibility testing.

A weak and incomplete right palpebral reflex was noted immediately after surgery, which was presumably caused by facial nerve paresis. Artificial tears were applied for 7 days until the affected eyelid regained satisfactory function.

Reevaluation at the time of suture removal (at 14 days) by the referring veterinarian revealed identical facial nerve paresis with a weak and incomplete palpebral reflex and a dropped upper right lip with decreased muscle tone. The surgical incision had healed without any complications. Communication with the owners at >12 months postoperatively confirmed continued presence of facial nerve paresis with the same weak and incomplete palpebral reflex; however, artificial tears were not needed. The tone in the lip was almost back to normal, and the dog was otherwise asymptomatic.

Discussion

Otitis externa is the most common ear disease of the dog and cat and is estimated to affect 5% to 20% of the canine

Figures 3A-3D—Transverse (A) T2-weighted, (B) fluid-attenuated inversion recovery (FLAIR), (C) T1-weighted precontrast, and (D) T1-weighted postcontrast images at the level of the follicular cysts (arrowheads: ear canal wall). The signal of the cyst material varies according to each sequence, including (A) hyperintensity, indicating a fluid and/or fat component (as compared with the almost complete attenuation seen with fat saturation); (B) lack of attenuation seen with FLAIR (indicating a cellular or proteinic component); and (C, D) no contrast enhancement, indicating an absence of vascularization. Abnormal tissue extends into the tympanic bulla (asterisk). The fistula can also be seen (arrow). Both the fistula and ear canal wall contrast enhance (C, D). The left ear canal (N) is normal.
population.\textsuperscript{7,8} Otitis media is often an extension of otitis externa, and the incidence of otitis media in dogs with chronic otitis externa has been reported to be as high as 52\% to 60\%.\textsuperscript{9-12} When evaluating an animal with otitis externa, it is important to determine the primary cause as well as any predisposing and perpetuating factors, so as to manage the otitis properly. Dermatological and neurological examinations should be performed, because concurrent dermatological disease is seen in 64\% to 80\% of cases.\textsuperscript{2,3} and preoperative facial neuropathy occurs in approximately 15\% of dogs with end-stage otitis.\textsuperscript{6} A thorough otoscopic examination (video or handheld) should also be performed on every animal with otitis externa.\textsuperscript{13} Both ears should be examined even if only a unilateral otitis externa is suspected.\textsuperscript{13}

Para-aural swelling and fistulation can occur secondary to ear canal stenosis; these conditions are most commonly caused by hyperplastic proliferation in chronically diseased ears.\textsuperscript{4} Otitis media, foreign body migration, traumatic ear canal separation, diseases involving the parotid gland or the dental arcade, and osteomyelitis of the petrous temporal

\textbf{Figures 4A, 4B}—Appearance of the resected ear canal. (A) Multiple follicular cysts are seen in the horizontal portion of the ear canal (2). The vertical portion of the ear canal (1) and annular cartilage forming the external auditory meatus (3) can also be seen. (B) The ventral aspect of the horizontal portion of the ear canal has been transected. Follicular cyst material is present (4).

\textbf{Figures 5A, 5B}—Histopathology of the mass (25×). (A) a) lumen of the right ear canal; b) stratified epithelial lining; c) dense connective tissue secondary to chronic fibrosis; d) cyst wall; e) keratin within a follicular cyst (100×). (B) a) keratin within a ruptured follicular cyst; b) extracystic keratin within a chronic pyogranulomatous reaction; c) dense connective tissue.
bone constitute other causes of fistulation.14,15 Fistulae also develop in 3% to 15% of dogs treated for chronic otitis by TECA and either lateral or ventral bulla osteotomy.2,3,6,15,16

Either video or handheld otoscopy can be used for the diagnosis of ear diseases in small animals; however, video otoscopy has several advantages over the handheld otoscope. Video otoscopy provides a high degree of magnification, allowing greater visualization and detailed resolution of the ear canal and tympanic membrane. Compared to handheld otoscopy, some disadvantages of video otoscopy are that the animal must be anesthetized and placed in lateral recumbency; saline is needed for visualization; and more equipment and staff are required for the procedure to be performed.13 Diagnostic imaging techniques (i.e., conventional radiography, computed tomography [CT], and MRI) can become useful when otoscopy is impossible or nondiagnostic; when complete assessment of the tissues surrounding the ear canal is needed; or when the middle ear needs evaluation.17-19 Radiography is commonly used but often lacks sensitivity.17-21

Cross-sectional imaging techniques are complementary imaging techniques that are used in referral, not general, practices to assess the contents of and pathological changes affecting the external ear canal, the middle ear, labyrinth, and internal auditory canal.20,21 Fistulography may be useful to define fistula length, location, and origin.14 Although ultrasonography has been reported to evaluate the tympanic bulla and ear canals, it has several limitations compared to other imaging modalities and is not recommended as a replacement for radiography, CT, or MRI.19

In the case presented here, ultrasound was a useful adjunct to evaluate the subauricular mass, and it allowed us to obtain cytological information. Computed tomography provides excellent cross-sectional images of the ear canal, tympanic bulla, and internal ear; superimposition is eliminated, and image contrast is superior to that provided by conventional radiography.7,21 Magnetic resonance imaging also eliminates superimposition and is superior for imaging soft tissue components. As illustrated in this case, MRI also provides specific information on tissue composition through various imaging sequences.21 For example, the fat-suppression images showed attenuation of the cyst material, indicating the soft tissue mass had a fatty component that was consistent with cerumen or sebaceous material. In complex cases such as the one reported herein, more than one imaging technique may be required for diagnosis.

Ear canal masses or mass-like lesions have previously been reported in dogs and include abscessation, ceruminous gland hyperplasia, and benign or malignant tumors.22,23 Ear canal tumors in dogs and cats are relatively uncommon, representing only 1% to 2% of all tumors in cats24,25 and 2% to 6% of all tumors in dogs admitted for aural surgery.26,27 Ear canal tumors tend to be more aggressive in cats than in dogs.23 The most commonly reported aural tumors affecting dogs include ceruminous gland adenoma and adenocarcinoma, papilloma, and histiocytoma.25-27 In the cat, ceruminous gland adenoma and adenocarcinoma are also common, and, unlike dogs, cats are more frequently diagnosed with inflammatory polyps involving the middle ear and squamous cell carcinoma of the pinnae.23

To our knowledge, multiple follicular cysts have never been reported in the ear canals of dogs or cats. In humans, epidermal cysts occur most commonly on the face, scalp, neck, and trunk; for epidermal (follicular) cysts to appear in the external auditory canal is extremely rare.28 Only two human cases of epidermal (follicular) cysts of the external auditory canal appear to have been reported to date.29,30 In dogs and cats, follicular cysts are considered benign skin lesions that can be surgically removed and have no tendency to recur.31

Follicular cysts, epidermoid cysts, epidermal inclusion cysts, epidermal cysts, and infundibulorum neoplasia occluding the lum en of the horizontal ear canal, collapse/stenosis of the horizontal ear canal caused by infection, and calcified periauricular tissues.2 Aural trauma
and obstructive congenital malformations are also indications for surgical intervention.\textsuperscript{14,27,33,34}

In the TECA-LBO preoperative period, it is important to determine any preexisting complications and to ensure that the owner has a firm understanding of the possible treatment-related complications associated with this procedure.\textsuperscript{2,5} Facial nerve deficits, as seen in this case, are common.\textsuperscript{2,5} The facial nerve or branches of the facial nerve can be damaged during dissection or tissue retraction. Clinical signs include a slow or absent palpebral reflex and hemifacial paresis leading to drooping of the ipsilateral eye and lip margins.\textsuperscript{4,14,33} With proper treatment, this complication is often temporary and free of long-term sequelae.\textsuperscript{2,5} In 10\% to 15\% of cases, facial nerve damage is permanent; however, long-term artificial tear application is not necessary, because continued lacrimal function, passive movement of the third eyelid (controlled by cranial nerve VI), and abducens nerve-mediated globe retraction are sufficient to ensure a proper corneal tear film.\textsuperscript{3,4}

Conclusion

Multiple follicular cysts with otitis media and externa were diagnosed and evaluated in a dog with the aid of ultrasound, MRI, cytology, and histopathology. Surgical treatment was curative and associated with only minor complications. Based on the results of this report, TECA-LBO appears to be a viable treatment for otitis externa and media associated with multiple follicular cysts of the external ear canal.

Acknowledgments

The authors thank Dr. Michel Desnoyer and Dr. Manon Paradis for their clinical expertise; Dr. Pierre Hélie for providing the histopathological images; and Mr. Richard Bourassa for image editing.

Footnotes

\textsuperscript{a} Clavamox; Pfizer, Kirtland, Quebec, Canada H9J 2M5
\textsuperscript{b} Baytril; Bayer, Toronto, Ontario, Canada M9W 1G6
\textsuperscript{c} Apo-Cephalex; Apotex, Inc., Weston, Ontario, Canada M9L 1T9
\textsuperscript{d} HDI 5000 ultrasound machine; Advanced Technology Laboratories, Inc., Bothell, WA 98021
\textsuperscript{e} GE Echospeed; General Electric, Milwaukee, WI 53209-4403
\textsuperscript{f} Multihance; Bracco Diagnostics Canada, Inc., Mississauga, Ontario, Canada L4T 3S6
\textsuperscript{g} PDS II, ETHICON; Johnson and Johnson Company, New Brunswick, NJ 08933
\textsuperscript{h} Monocryl, ETHICON; Johnson and Johnson Company, New Brunswick, NJ 08933
\textsuperscript{i} Monosof; Tyco Healthcare, United States Surgical Corporation, Norwalk, CT 06856
\textsuperscript{j} Fentanyl Citrate injection USP; Hospira Healthcare Corporation, Vaughan, Ontario, Canada L4T 4T7
\textsuperscript{k} Hydromorphone hydrochloride injection USP; Sandoz Canada, Inc., Quebec, Canada J4B 7K8
\textsuperscript{l} Metacam; Boehringer Ingelheim, Burlington, Ontario, Canada L7L 5H4

References

A 4-year-old Yorkshire terrier was presented for an esophageal foreign body. After removal of the foreign body, clinical signs of gagging, regurgitation, and vomiting continued unabated for >6 weeks. The dog had enlarged submandibular salivary glands that were histologically normal. Treatment with phenobarbital resulted in a rapid and dramatic resolution of clinical signs. After 3 months, the dog was weaned of phenobarbital and was free of any signs of disease 6 months later. J Am Anim Hosp Assoc 2010;46:115-120.

Introduction

Sialadenosis is a bilateral, uniform, painless, noninflammatory, nonneoplastic enlargement of the salivary glands. In humans, it is often the result of physiological hypertrophy in response to chronic stimulation (as seen in bulimic patients), or it can be secondary to autonomic neuropathies (e.g., alcoholism and type 2 diabetes mellitus). Rarely, no underlying disease can be found.1

Sialadenosis is rare in dogs. In a retrospective series of dogs and cats with salivary gland disorders, none of the 160 dogs was diagnosed with sialadenosis.2 Only a few individual cases and two case series of sialadenosis in dogs have been reported.3-12 One of these case series describes 19 cases with salivary gland necrosis, 14 of which did not respond to phenobarbital and were associated with an underlying esophageal disease.3 The other case series describes 13 dogs with phenobarbital-responsive sialadenosis and no apparent underlying disease.4 Based on these studies, esophageal disease in dogs may be associated with sialadenosis that is nonresponsive to phenobarbital. Most cases of phenobarbital-responsive sialadenosis have not been associated with esophageal disease. In one case report, however, esophageal spasm and narrowing were suspected to be manifestations of phenobarbital-responsive sialadenosis.5

Here we report for the first time a case of phenobarbital-responsive sialadenosis associated with an esophageal foreign body. Although no cause and effect were established, the foreign body was not likely the cause of the sialadenosis, but it became lodged as a result of esophageal dysfunction.

Case Report

A 4-year-old, intact female Yorkshire terrier weighing 3.0 kg was referred to the University of Illinois Veterinary Teaching Hospital (VTH) for a 6-week history of intermittent vomiting, regurgitation, gagging, and mild weight loss. The dog was first presented to the referring veterinarian after choking on a piece of gristle. Thoracic radiographs at that time showed an esophageal foreign body that was subsequently pushed into the stomach with an endoscope. A gastric foreign body and mild ulceration in both the esophagus and the stomach were seen on endoscopy. Initial treatment included sucralfate and dexamethasone.
The dog was presented again to the referring veterinarian 9 days later for frequent, persistent vomiting (sometimes multiple times per hour), regurgitation, and gagging. No abnormalities were seen on thoracic and abdominal radiographs, and a second endoscopy revealed no abnormalities in the esophagus and stomach. Treatment with amoxicillin-clavulanic acid, metoclopramide, and trimeprazine-prednisolone failed, and the dog was presented again 2 weeks later to the referring veterinarian with the same clinical signs. A third endoscopy at that time revealed no abnormalities in the esophagus and stomach. Histopathological examination of esophagoscopic biopsies from the stomach also did not reveal any abnormality.

Treatment with sucralfate and cimetidine did not result in improvement, and the dog was presented 6 days later with the additional clinical signs of dehydration, inappetence, and lethargy. Blood tests revealed hemocrit, leukocytosis, moderate azotemia, high alkaline phosphatase (ALP) activity, and a high lipase concentration. Pancreatitis was suspected based on a high serum canine pancreas-specific lipase (cPLI) (444 µg/L, reference interval 0 to 200 µg/L). An exploratory laparotomy was performed, and no gross abnormalities were found. After 1 day of treatment with intravenous (IV) fluids (i.e., lactated Ringer’s solution [LRS]) and antiemetics, the dog was again bright and alert with a normal appetite.

Five days after surgery, complete blood count (CBC) and serum biochemical profile results were normal, but the dog was still vomiting, regurgitating, and gagging with the same frequency as in the initial visit for these problems. A fourth endoscopy at that time failed to reveal any abnormalities in the upper gastrointestinal tract. A percutaneous endoscopic gastrostomy (PEG) tube was placed, and the owner was instructed to feed Hill’s a/d and administer ondansetron, cisapride, and omeprazole through the feeding tube. A week later (6 weeks after the esophageal foreign body episode) and still with no change in frequency of the vomiting, regurgitation, and retching, the dog was referred to the VTH.

On presentation to the VTH, the dog was quiet, alert, and responsive. Vital signs were normal (temperature 39.0°C [101.7°F], heart rate 128 beats per minute, panting). Mucous membranes were pink and moist with a capillary refill time of <2.5 seconds. The dog was estimated to be <5% dehydrated. Body condition score was 3/9. The mandibular salivary glands were mildly enlarged. Fundic examination revealed normal retinas. No other abnormalities were seen on the physical examination.

Initial diagnostic tests revealed a packed cell volume of 36%, total solids of 9.0 g/dL, and a systolic blood pressure of 210 mm Hg (Doppler*). The CBC revealed mild normocytic normochromic anemia; a high total white blood cell count with mature neutrophilia and monocytosis; and normal lymphocyte, eosinophil, and platelet counts [Table 1].

<p>| Table 1 |</p>
<table>
<thead>
<tr>
<th>Complete Blood Count Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>WBCs</td>
</tr>
<tr>
<td>Neutrophils</td>
</tr>
<tr>
<td>Bands</td>
</tr>
<tr>
<td>Lymphocytes</td>
</tr>
<tr>
<td>Monocytes</td>
</tr>
<tr>
<td>Eosinophils</td>
</tr>
<tr>
<td>RBCs</td>
</tr>
<tr>
<td>Hemoglobin</td>
</tr>
<tr>
<td>Hematocrit</td>
</tr>
<tr>
<td>MCV</td>
</tr>
<tr>
<td>MCH</td>
</tr>
<tr>
<td>MCHC</td>
</tr>
<tr>
<td>Platelets</td>
</tr>
</tbody>
</table>

* WBCs=white blood cells; RBCs=red blood cells; MCV=mean corpuscular volume; MCH=mean corpuscular hemoglobin; MCHC=mean corpuscular hemoglobin concentration

---
Abnormal serum biochemical results included a moderate elevation in blood urea nitrogen concentration; a mild increase in the serum concentration of creatinine; borderline hyponatremia and hypochloridemia; severe hypokalemia; and increased ALP activity [Table 2]. The elevation in ALP was primarily due to an increase in the corticosteroid-induced ALP (cALP) fraction, consistent with chronic stress. The concentrations of albumin and globulins were normal. The bicarbonate concentration was slightly decreased, and the anion gap was slightly increased. Venous blood gases were measured a few hours after presentation and showed moderate acidemia (pH 7.225) and a metabolic acidosis with respiratory compensation (HCO₃⁻ 12.4 mmol/L, PCO₂ 29.9 mm Hg). Urine (obtained by cystocentesis) had a specific gravity of 1.018, and proteinuria, bacteriuria, and coarse granular casts were present [Table 3]. A sample of the urine was submitted for bacterial culture. Prothrombin time (PT) and partial thromboplastin time (PTT) were within normal limits (PT 7 seconds, reference interval 6.0 to 10.0 seconds; PTT 11 seconds, reference interval 6 to 16 seconds). Serum D-dimers were mildly increased at 250 to 500 ng/mL (reference interval <250 ng/mL).

Thoracic radiographs were unremarkable except for mild left atrial enlargement. No abnormalities were seen in the esophagus. Abdominal radiographs and ultrasound were also unremarkable except for the presence of radioopaque material that was consistent with barium within the PEG tube, stomach, and small and large intestines.

Differential diagnoses that were considered at this point included various structural and functional motility disorders of the pharynx and esophagus, with secondary complications related to the esophageal foreign body, exploratory

### Table 2

**Serum Biochemical Results**

<table>
<thead>
<tr>
<th>Test *</th>
<th>Day 1</th>
<th>Day 4</th>
<th>Reference Range</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creatinine</td>
<td>1.8</td>
<td>0.3</td>
<td>0.5-1.6</td>
<td>mg/dL</td>
</tr>
<tr>
<td>BUN</td>
<td>90.8</td>
<td>8.6</td>
<td>7-13</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Total protein</td>
<td>6.9</td>
<td>6.2</td>
<td>5.4-8.0</td>
<td>g/dL</td>
</tr>
<tr>
<td>Albumin</td>
<td>4.1</td>
<td>3.8</td>
<td>2.1-4.3</td>
<td>g/dL</td>
</tr>
<tr>
<td>Globulin</td>
<td>2.8</td>
<td>2.4</td>
<td>2.7-4.4</td>
<td>g/dL</td>
</tr>
<tr>
<td>Glucose</td>
<td>228</td>
<td>148</td>
<td>65-127</td>
<td>mg/dL</td>
</tr>
<tr>
<td>ALP</td>
<td>417</td>
<td>545</td>
<td>12-110</td>
<td>U/L</td>
</tr>
<tr>
<td>cALP</td>
<td>280</td>
<td>385</td>
<td>0-40</td>
<td>U/L</td>
</tr>
<tr>
<td>ALT</td>
<td>46</td>
<td>84</td>
<td>17-87</td>
<td>U/L</td>
</tr>
<tr>
<td>GGT</td>
<td>8</td>
<td>14</td>
<td>1-11</td>
<td>U/L</td>
</tr>
<tr>
<td>Total bilirubin</td>
<td>0.2</td>
<td>0.2</td>
<td>0.08-0.5</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>309</td>
<td>240</td>
<td>109-315</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>56</td>
<td>60</td>
<td>25-145</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Calcium</td>
<td>9.2</td>
<td>9.2</td>
<td>7.9-11.5</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>3.7</td>
<td>2.9</td>
<td>2.4-6.5</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Sodium</td>
<td>141</td>
<td>152</td>
<td>141-161</td>
<td>mmol/L</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.7</td>
<td>4.2</td>
<td>3.9-5.7</td>
<td>mmol/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>100</td>
<td>110</td>
<td>104-125</td>
<td>mmol/L</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>16.5</td>
<td>25</td>
<td>17-29</td>
<td>mmol/L</td>
</tr>
<tr>
<td>Anion Gap</td>
<td>26.2</td>
<td>21.2</td>
<td>8-25</td>
<td>mmol/L</td>
</tr>
</tbody>
</table>

*BUN=blood urea nitrogen; ALP=alkaline phosphatase; cALP=corticosteroid-induced ALP; ALT=alanine aminotransferase; GGT=gamma-glutamyltransferase
laparotomy, and PEG tube placement. Pyelonephritis was suspected based on the acute azotemia with inappropriate urine concentration, the presence of bacteria and casts in the urine, and the inflammatory leukon. Pancreatitis could not be ruled out. The hypertension was suspected to be secondary to pain or stress, but other causes (including endocrine or kidney diseases) were also considered.

The dog was hospitalized, and IV fluids were administered (LRS supplemented with potassium chloride [KCl] at 80 mEq/L). The dog also received buprenorphine (0.01 mg/kg IV q 6 hours), sucralfate (50 mg/kg, dissolved in water, via gastric tube q 8 hours), famotidine (1 mg/kg IV q 24 hours), metoclopramide (0.03 mg/kg IV q 6 hours), and ampicillin (22 mg/kg IV q 8 hours). On day 2, maropitant† (1 mg/kg subcutaneously q 24 hours) was added after no change was seen in the frequency of the vomiting. Serum potassium concentrations were monitored frequently, and they gradually normalized. By day 3, the KCl supplementation was decreased to 20 mEq/L of IV fluid. The dog’s systolic blood pressure remained elevated throughout this time (ranging from 180 to 230 mm Hg), and enalapril was begun (0.42 mg/kg via gastric tube q 12 hours). Although the dog was now bright and alert, she was still gagging almost constantly and had frequent episodes of vomiting and regurgitation (sometimes multiple times per hour).

On day 4, the azotemia and electrolyte imbalances resolved, and the inflammatory leukon was resolving [Tables 1, 2]. Fine-needle aspirates of the enlarged submandibular salivary glands were taken, and cytology revealed no abnormalities. The serum cortisol concentration was measured to rule out atypical hypoadrenocorticism; the concentration was within normal range (cortisol 72.0 nmol/L, reference interval 58 to 144 nmol/L). The next day, the dog was anesthetized, and wedge biopsies were obtained from the submandibular salivary glands. Endoscopy of the esophagus, stomach, and duodenum revealed no abnormalities. Biopsies of the intestinal tract were obtained, and the sucralfate was discontinued. The urine culture grew *Enterococci* (>30,000 colony-forming units per mL) that were sensitive only to trimethoprim-sulfadiazine (TMS). Ampicillin was discontinued, and TMS was initiated (30 mg/kg via gastric tube q 12 hours). Systolic blood pressure decreased to 150 mm Hg, and buprenorphine was discontinued.

On day 6, an esophagram was performed using fluoroscopy. Oropharyngeal and esophageal motility was normal after administration of liquid barium, although repeated contractions could be seen in the pharynx after swallowing, and the dog was gagging. A large bolus of barium-impregnated soft food and kibble accumulated in the pharynx before pharyngeal contraction was initiated. This was followed by normal esophageal transit, although repeated contractions of the pharynx could again be seen after swallowing of the food.

Sialadenosis was diagnosed on the basis of pharyngeal dysfunction and salivary gland enlargement, normal cytology and histopathology of the salivary gland, and the lack of any structural or histopathological abnormalities in the oropharynx, esophagus, stomach, or duodenum. An acetylcholine-receptor antibody titer was submitted to rule out myasthenia gravis as the cause of pharyngeal dysfunction, and it was normal (0.12 nmol/L, reference interval 0.0 to 0.6 nmol/L). Treatment with phenobarbital was initiated (1 mg/kg via gastric tube q 12 hours), and TMS and enalapril were continued. Famotidine, maropitant, and metoclopramide were discontinued.

Clinical improvement was seen within a few hours of phenobarbital administration. The dog’s attitude improved, and the frequency of the gagging, regurgitation, and vomiting decreased. By the next day (day 7), the dog was eating and drinking normally. No more vomiting or gagging episodes were observed, and the regurgitation episodes became infrequent. The dog was sent home on phenobarbital, TMS, and enalapril, and she remained free of any clinical signs of disease for the next 3 months. After 1 month, TMS and enalapril were discontinued. After 3 months, the dog was slowly weaned off phenobarbital. Six months after being released from the hospital, the dog was in good body condition, was healthy, and was not receiving any medications.

**Discussion**

Phenobarbital-responsive sialadenosis is a rare, idiopathic disease in dogs. It is characterized by a sudden onset of

---

**Table 3**

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>1.018</td>
</tr>
<tr>
<td>pH</td>
<td>5.0</td>
</tr>
<tr>
<td>Protein</td>
<td>100</td>
</tr>
<tr>
<td>Glucose</td>
<td>Negative</td>
</tr>
<tr>
<td>Ketones</td>
<td>Negative</td>
</tr>
<tr>
<td>Bilirubin</td>
<td>2+</td>
</tr>
<tr>
<td>Blood</td>
<td>Moderate</td>
</tr>
<tr>
<td>WBCs*</td>
<td>2-4</td>
</tr>
<tr>
<td>RBCs†</td>
<td>Rare</td>
</tr>
<tr>
<td>Epithelial cells</td>
<td>1-2</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Many</td>
</tr>
<tr>
<td>Casts</td>
<td>Few coarse granular</td>
</tr>
</tbody>
</table>

* WBCs=white blood cells
† RBCs=red blood cells
retching and gulping with bilateral enlargement of salivary glands, most commonly the submandibular glands.\footnote{3,5,7,12} Ptyalism, gagging, lip-smacking, weight loss, decreased appetite, and vomiting are also reported. The combination of these clinical signs with enlargement of salivary glands has been reported with an underlying esophageal disease as well as in one case series of 19 dogs with salivary gland necrosis. In these 19 cases, however, only treatment of the underlying disease brought about resolution of clinical signs, while treatment with phenobarbital did not.\footnote{3} In truly idiopathic cases, when no disease process can be identified in the salivary glands, pharynx, or esophagus, treatment with phenobarbital typically results in significant improvement within 24 to 36 hours, complete resolution of clinical signs within 1 week, and a decrease in size of the salivary glands within 2 to 4 weeks.\footnote{4,5,7} In some cases, salivary gland necrosis has been reported.\footnote{3,9-11} This was most likely a secondary process, because surgical removal of the glands did not result in improvement, while treatment with phenobarbital did.\footnote{3,9-11}

Idiopathic sialadenosis has been proposed to be a form of limbic epilepsy based on electroencephalographic tracings consistent with seizure activity and the response to antiepileptic drugs (i.e., phenobarbital,\footnote{3,5,7-11} phenytoin,\footnote{12} potassium bromide\footnote{7}). Limbic epilepsy does not seem likely considering that five out of six reported cases that were tested had normal electrodiagnostic results.\footnote{3,7,9} Also, the response to antiepileptic drugs is seen before a steady-state therapeutic concentration can be reached, with lower doses and shorter durations of treatment than those typically required for idiopathic epilepsy.\footnote{4,5,7} However, limbic epilepsy may simply require smaller dosages of antiepileptic drugs for treatment compared to dosages required for idiopathic epilepsy treatment.

In the case reported here, the dog was first presented for an esophageal foreign body. Mild ulceration was seen endoscopically after the foreign body was pushed into the stomach. It is unclear whether the lodging of the foreign body was the initiating cause of or was secondary to esophageal dysfunction. In one case series of 19 dogs, salivary gland necrosis secondary to esophageal disease was associated with chronic and severe conditions (e.g., esophageal granuloma or neoplasia from Spirocerca lupi) and was not responsive to phenobarbital administration.\footnote{3} In the case reported here, follow-up endoscopic examinations revealed a normal esophagus and stomach while the dog had severe clinical signs. Therefore, it seems unlikely that the foreign body was the initiating cause in this case.

Esophageal dysfunction could have caused the lodging of the foreign body. One case of phenobarbital-responsive sialadenosis with intermittent narrowing of the esophagus due to muscular spasm has been reported.\footnote{5} In the case reported here, no structural or functional abnormalities were detected in the esophagus, but intermittent muscular spasm and narrowing could not be ruled out. Most likely the lodging of the foreign body was caused by an esophageal disorder, and this was an unusual manifestation of the phenobarbital-responsive sialadenosis syndrome rather than the cause of it.

This case was challenging because of the rarity of the syndrome and because the dog had multiple concurrent problems. Pylonephritis, pancreatitis, and local peritonitis (in the PEG tube or surgical sites) could all account for the vomiting, inappetence, inflammatory leukon, and increased cALP. As mentioned previously, pylonephritis was suspected based on the findings of a urinary tract infection and acute renal insufficiency. A diagnosis of pancreatitis prior to presentation to the VTH was supported by an increased cPLI. No evidence of pancreatitis was seen during exploratory laparotomy at that time, but pancreatic biopsies were not obtained. Importantly, a urinalysis was not performed. Pylonephritis may have been the cause of the inflammatory leukon and a contributor to the vomiting, but it is unlikely to have caused the increased cPLI. Glucocorticoid administration has been suspected (although not proven) to be a cause of increased cPLI.\footnote{13}

The cause of the severe hypokalemia was not determined. Decreased intake, increased loss (gastrointestinal and renal), and transcellular shifts were considered. None of the medications administered prior to the development of hypokalemia were likely responsible. The severe hypokalemia was probably not directly related to the phenobarbital-responsive sialadenosis, because it resolved with symptomatic treatment before treatment with phenobarbital was initiated, and this has not previously been reported in similar cases.\footnote{4,5,7,8} Potassium concentration in canine saliva is three to seven times higher than the serum potassium concentration.\footnote{14} Ptyalism was not observed in this dog, and increased production and subsequent swallowing of saliva would not have resulted in loss of potassium from the body. Severe loss of potassium secondary to inappropriate use of the PEG tube may have been responsible for the hypokalemia. Concurrent metabolic alkalosis would be expected, but this may have been masked by metabolic acidosis secondary to acute renal failure, hypoperfusion, and lactic acidosis. In this particular case, it seemed that the degree of acute renal failure, hypoperfusion, and lactic acidosis, when considered separately, was not severe enough to explain masking alkalosis; but in combination, they may have been sufficient.

**Conclusion**

To the best of our knowledge, this is the first report of an esophageal foreign body associated with phenobarbital-responsive sialadenosis. Intermittent esophageal dysfunction may be a component of this disease and may have caused the lodging of the foreign body. The combination of enlarged salivary glands with signs of pharyngeal or esophageal disease should raise the suspicion of phenobarbital-responsive sialadenosis. The diagnosis, however, can only be made after a diagnostic workup to rule out other diseases. The response to treatment in this disorder is rapid, and the prognosis is good. Standard guidelines for treatment with antiseizure medication may not necessarily apply in this disorder. Response to therapy may be seen before steady state is reached, and it may not be necessary to
achieve the level of plasma concentration necessary for control of epileptic seizures.

Footnotes

a Clavamox; GlaxoSmithKline, Research Triangle Park, NC 27709
b Temari-P; Pfizer Animal Health, Exton, PA 19341
c Spec cPL Test; IDEXX Laboratories, Inc., Westbrook, ME 04092
d Hill’s A/D; Hill’s Pet Nutrition, Inc., Topeka, KS 66603
e Parks Medical Electronics, Inc., Aloha, OR 97007
f Cerenia; Pfizer Animal Health, Exton, PA 19341

Acknowledgments

We thank Mr. Benjamin Johnson for his technical support with the video images.

References

Surgical Resection of a Mature Teratoma on the Head of a Young Cat

A 4-month-old kitten was presented with a large mass over the temporal area involving the base of the left ear. Cytological evaluation of a fine-needle aspirate was not diagnostic. Computed tomography was used to determine tumor extent. Surgical resection was performed, which included parts of the orbital rim, masticatory muscles, the complete ear canal, and the pinna. Reconstruction of the ocular muscles was performed, and the skin defect was reconstructed using a single pedicle advancement flap. Despite unilateral facial paralysis, postoperative clinical function was excellent and aesthetics were good. Histological examination revealed the tumor to be a teratoma. After a follow-up period of 3 years, no signs of recurrence were evident. Extragonadal teratomas should be considered in the differential diagnosis when young animals are presented with a growing mass located outside the abdominal cavity. Surgical excision of a mature teratoma can be considered curative.


Introduction

Teratomas are complex tumors composed of multiple tissues foreign to the part of the body in which they arise. They originate from pluripotent germ cells that undergo somatic differentiation into two or usually three embryonic germ cell layers, and a variety of mature tissues are arranged chaotically throughout the tumor. Any combination of ectodermal (skin and appendages), mesodermal (osseous, cartilaginous, adipose, or muscle structures), and endodermal tissues (glandular tissues) can be seen.

Very few feline teratomas have been reported. They most commonly originate from the ovary or testicle because of their germ cell origin. To the authors’ knowledge, only two cases of an extragonadal teratoma have previously been reported in cats. Chénier et al described a kitten with an intracranial teratoma. Location and secondary lesions prohibited surgical treatment, and euthanasia was elected. Wray et al described a cat with a retrobulbar teratoma that was successfully treated by surgical excision.

This article describes the successful excision of a mature extragonadal teratoma located on the skull of a 4-month-old kitten.

Case Report

A 3-month-old, domestic shorthair kitten was presented for examination of a soft mass, measuring $5 \times 6 \times 3$ cm, on the head over the temporal area near the base of the left ear [Figure 1]. The mass had reportedly been present 2 weeks prior to presentation when this stray kitten was found and adopted by the current owner. At that time, the mass was approximately 2 cm in diameter. Radiographs revealed a soft tissue swelling on the left side of the cranium, with a heterogeneous opacity including areas of mineralization [Figure 2]. On cytological examination of a fine-needle aspirate, keratinocytes were observed along with keratinaceous debris on an amorphous background. Further diagnostic options (i.e., computed tomography [CT] scan and biopsy) were recommended to the owner but were not pursued at that time.
Because the mass continued to grow, the kitten was reevaluated 1 month later. The soft tissue mass extended from the lateral commissure of the eye to the caudal extent of the skull and completely enveloped the ear base and pinna (10 × 15 × 8 cm). Further staging of the disease was performed. Regional lymph node aspirates and thoracic radiographs did not show any signs of metastasis. Cytological examinations of aspirates of the tumor at various locations were performed. These revealed the same hypocellular material that was again considered nondiagnostic. The owner declined a biopsy procedure, and the decision was made to perform CT scans to determine tumor margins and invasiveness and then to remove the tumor as an excisional biopsy [Figure 3].

The kitten was given xylazinea (1 mg/kg intramuscularly) and induced with propofolb (4 mg/kg intravenously [IV] to effect). An endotracheal tube was placed, and anesthesia was maintained with isoflurane in oxygen, using a semiclosed rebreathing system. Prior to surgery, the kitten received amoxicillin³ (10 mg/kg IV) and carprofen³ (4 mg/kg IV). During surgery, fentanyl was administered at 5 µg/kg per hour.

The mass was removed according to commonly recognized principles of oncological surgery. An attempt was made to perform local wide excision; however, at some locations the plane of dissection was close to the tumor’s pseudocapsule (marginal resection) [Figure 4]. Superficial cutaneous and auricular muscles were transected. The temporal fascia was incised along the left side of the external sagittal crest. Dorsal to the zygomatic process, the temporal and masseter muscles were transected. The ear canal was resected at the external auditory meatus. The facial nerve was sacrificed because of its entry into the mass. After tumor resection, the entire parietal and part of the temporal bones were exposed [Figure 5]. To prevent drooping of the lateral eye commissure, the orbicularis oculi muscles were attached to the remaining muscle fascia at the external sagittal crest with two horizontal mattress sutures (polypropylene 4-0) [Figure 6]. In the same manner, the auricular muscles from the right side were reattached to this medial ridge. A single pedicle advancement flap from the neck was used to close the skin defect [Figure 7]. The subcutaneous
tissues were apposed with simple interrupted sutures (polydioxanone 3-0), and the skin was closed with a continuous intradermal suture (polyglecaprone 4-0).

Postoperatively, a pressure bandage was placed around the skull (in a figure-of-eight pattern around the contralateral ear) for the first 48 hours. The left eye was lubricated with hypromellosum. Analgesia was provided with morphine (0.3 mg/kg per hour for 19 hours) and carprofen (4 mg/kg orally q 24 hours for 3 days).

The mass was fixed in neutral-buffered formalin (10%) and processed for paraffin sectioning, and 5-µm sections were stained with hematoxylin and eosin according to standard techniques. Microscopic examination revealed the following: cystic cavities that were lined by stratified epithelium and often filled with keratinized squamous cells and hair shafts; cysts lined by pseudostratified ciliated epithelium; numerous hair follicles and hair bulbs; multifocal islands of hyaline cartilage; adipose tissue; and spindle cell proliferation [Figure 8]. These findings are consistent with the diagnosis of a teratoma. Surgical margins were evaluated and considered to be free of abnormal cells.
On follow-up examination 2 weeks later, the wound had healed unremarkably. As was expected, no blinking of the left eyelids nor a palpebral reflex were observed. Opening of the mouth during eating or yawning was neither limited nor painful. Eye medication had previously been discontinued without consequence. Digital photographs [Figure 9] sent in by the owner and a telephone consultation 3 years later revealed that the cat had a normal quality of life without any signs of recurrence.

Discussion

This report describes an extragonadal teratoma in a 4-month-old kitten. A literature review found only nine other cases of teratomas in the cat.1,2,4,6-10 The median age of these nine cats was 3 years (range 4 months to 17 years). The young age at presentation in this case is most likely due to the extragonadal location, where tumors are more easily recognized by the owner. This is reflected in the different presentation ages between cats with gonadal (mean 3 years, median 4.9 years) and extragonadal teratomas (mean and median 1.7 years).

Few conclusions can be made regarding the location of the teratoma in the present case, because the incidence of this tumor in cats is low (0.7% to 3.6%).3

In humans, extracranial teratomas of the head and neck region are rare.13,14 Most are diagnosed around birth and during the first 3 months of life.14 Complete surgical excision has the lowest relapse rate14 and the highest probability for event-free survival.15

In animals, teratomas are most common in horses, and rare cases of temporal teratomas (i.e., open mass-like lesions or cystic tumors of the temporal bone occurring inferior to the ear canal) have been described only in horses.16,17 In small animals, Lambrechts et al described a 1.5-year-old dog with a mandibular teratoma originating from the salivary gland.13 Seven months after treatment, this dog was clinically normal. More recently, Wray et al described a 3-year-old cat with a small retrobulbar teratoma. The mass was successfully removed surgically, but no data regarding follow-up were presented.9

Although cytology is a common method for diagnosing tumors, in this case cytological examination was not sufficient to diagnose the tumor type. The presence of several cell types and an amorphous background are considered typical of a (mature) teratoma. In some cases, however, one of these elements may dominate the cytological picture.18 Findings in this case were a moderately cellular sample that yielded only keratin debris and mature keratinocytes with pyknotic nuclei. Further evidence of a teratoma was not found, and the sample was considered to be nondiagnostic. This corresponds with the two other clinical case reports of lateral teratomas (i.e., feline retrobulbar teratoma and canine salivary gland teratoma), which both described inconclusive cytology results.9,13

Before surgical tumor excision is performed, a definitive diagnosis obtained via biopsy is typically recommended.11 The information gathered can help predict prognosis prior to surgery and guide the surgeon with regard to the extent of surgical resection (e.g., intralesional, marginal, wide and en-bloc resection).19 In this case, an anesthetic procedure to perform an incisional biopsy was suggested to the owner but was declined. Since further staging at a later date did not confirm the presence of metastasis, it was felt that surgical excision, although very invasive, provided a chance for local tumor control.

The extent of surgery was determined based on the CT scan. A heterogeneous tumor was shown to be connected to the dorsolateral structures of the skull (i.e., pinna, ear canal,
muscle tone on the affected side is common. In cats, how-
sensory fibers leave the main trunk of the facial nerve to
form the tympanic nerve. The main trunk of the facial nerve
gland secretion. During the nerve’s course through the
ulation. Drooping of the ear and lip as a result of absent
defect, and location. An axial pattern flap technique was
include local flaps, indirect flaps, axial pattern flaps, free
would have allowed the preservation of large parts of the
temporal and masseter muscles and the overlying skin.
Techniques for the reconstruction for head wounds include local flaps, indirect flaps, axial pattern flaps, free
skin grafts, and free tissue transfer. The technique used
depends on the availability of local skin, the size of the
defect, and location. An axial pattern flap technique was
not used, because both the superficial temporal and the caudal auricular arteries and veins were sacrificed during tumor resection, leaving only the more distant omocervical ves-
s. A local single pedicle advancement flap was chosen because of the abundant amount of loose skin available in
the neck. This technique is straightforward and is estheti-
cally preferable, because it maintains the direction of hair
growth and creates smaller “dog ears.” An advancement flap
is limited in the amount of tissue it brings in, and it is sus-
cetible to tension; therefore, it should be used cautiously
close to the eyelids. The facial nerve supplies motor innervation to the mus-
cles of facial expression (including muscles of the eyelids, ear, nose, cheeks, and lips) and the caudal portion of the
digastric muscle. It also supplies parasympathetic fibers to
the palate, to the rostral two-thirds of the tongue for taste, and to all major exocrine glands of the head (e.g., lacrimal
and salivary) except the parotid and zygomatic salivary
glands. The facial nerve is also sensory to the external ear
canal. Clinical manifestations of facial nerve paralysis in
cats include an inability to close the eyelid, move the lips, and move the ear. Affected animals are unable to blink spontane-
ously or in response to visual or palpebral sensory stim-
ulation. Drooping of the ear and lip as a result of absent
muscle tone on the affected side is common. In cats, how-
ever, the firm subcutaneous maxillary plane allows com-
plete facial paralysis to be accompanied by an almost
normal position of the lip. Keratoconjunctivitis sicca may
develop following loss of facial nerve-stimulated lacrimal
gland secretion. During the nerve’s course through the
facial canal in the petrosal bone, the parasympathetic and
sensory fibers leave the main trunk of the facial nerve to
form the tympanic nerve. The main trunk of the facial nerve
exits at the stylomastoid foramen, while the tympanic nerve
follows a different course and runs through the middle ear.
In this kitten, the facial nerve was cut after it exited the
stylomastoid foramen, so only the motor branches were cut. The intact stimulation of the lacrimal gland was apparently
able to compensate for the inability to blink, and this
explains why it was possible to discontinue the tear drops
1 week after surgery without adverse effects. The other reason
is that the retractor bulbii muscle, which is innervated by the
abducens nerve, pulls the globe caudally and allows the lids
and nictitans to close passively to some extent, aiding in the
distribution of lubricating tears.
Young cats are at risk of developing middle ear disease
by extension of pharyngeal viral or bacterial pathogens
through the eustachian tube. In this kitten, the entire exter-
nal ear canal was resected, leaving the tympanic membrane
intact. A lateral bulla osteotomy to remove the epithelial lin-
ing of the tympanic bulla was not performed. The normal
route of drainage of middle ear epithelial secretions is
through the auditory (eustachian) tube. Obstruction of this
tube with concurrent otitis media can give rise to abscess
formation which, because of the absence of an external ear
canal, can extend into the subcutaneous space. The
owner was asked to pay specific attention to respiratory
infections and swellings of the surgical site. Three years
after surgery, no complications have been observed.
In the World Health Organization’s histological classifi-
cation based on the cellular morphology of the tumor, human teratomas are commonly classified using the
Gonzalez-Crussi grading system. According to this system, 0 or mature is benign; 1 or immature is probably benign; 2 or immature is possibly malignant; and 3 or immature is malignant. Teratomas are also classified by their content. A solid teratoma contains only tissues, perhaps including more
complex structures. A cystic teratoma contains only pockets of fluid or semifluid, such as cerebrospinal fluid, sebum, or fat. A mixed teratoma contains both solid and cystic parts.
Prognosis is primarily dependent on the nature of the
teratoma. Mortality in children is dictated by malignant histology and, in the case of mature teratomas, by occurrence
at certain sites. In humans, the metastatic rate is only 5%,
with the majority of tumors being local and metastasis
believed to occur through the lymphatic vessels. In dogs, the metastatic potential for an immature teratoma (terato-
carcinoma) is much higher at 32%. Local metastases have
been reported in multiple abdominal sites, and distant
metastases have been reported in the lungs, the cranial
mediastinum, and bone. No similar data are available for
cats because of the small number of cases described, but
malignancy and metastasis have both been documented.
Norris (1969) describes a solid teratoma in a cat with dys-
ergimomas; the tumor grew invasively and extended
through the abdominal wall. Although this tumor was con-
sidered malignant, no metastases could be documented. A
later case report described a teratoma in a cryptorchid testis
of a 2-year-old cat with a histologically confirmed meta-
static mass in the omentum. One month later, abdominal
ultrasonography was performed, and findings were suggestive of abdominal metastases. Because no postmortem examination was performed, it was unclear whether metastasis occurred via lymphatics or simply by implantation.

In contrast to immature teratomas, mature (benign) teratomas only cause clinical signs in relation to their size, and the prognosis depends on the location (i.e., the feasibility of complete surgical resection). For gonadal teratomas in dogs, survival times of up to 6 years have been reported.27

Conclusion

This report documents the appearance of an extragonadal mature teratoma in a kitten. It was not possible to diagnose this tumor using cytology, and an aggressive excisional biopsy was performed. Marginal surgical resection proved sufficient to completely remove the tumor. Prognosis for an extragonadal teratoma is dependent on tumor type (malignancy) and location. When complete excision of this sometimes fast-growing tumor is achieved, surgical treatment has the potential to be curative. This type of tumor, although rare, should be listed in the differential diagnosis for head and neck tumors in kittens.

Footnotes

1. Xyl-M 2%; VMD, Arendonk, B-2370 Belgium
2. Propovet; Abbott Laboratories, Queensborough, ME11 5EL United Kingdom
3. Sipromat 656; Dräger, Lübeck, G-23542 Germany
4. Clamoxyl; GlaxoSmithKline n.v./s.a., Genval, B-1332, Belgium
5. Rimadyl; Pfizer Animal Health s.a., Louvain-La-Neuve, B-1348 Belgium
6. Fentanyl-Janssen; JanssenCilag, Berchem, B-2665 Belgium
7. Prolene; Ethicon, St-Stevens-Woluwe, B-1932 Belgium
8. PDSII; Ethicon, St-Stevens-Woluwe, B-1932 Belgium
9. Monocryl; Ethicon, St-Stevens-Woluwe, B-1932 Belgium
10. IsopotoTears; Alcon, Puurs, B-2870 Belgium
11. Morphini HCl 10 mg; Laboratoria Sterop, Brussels, B-1070 Belgium

Acknowledgments

The authors are grateful to Dr. Ingrid Gielen from the Medical Imaging Department for providing the radiographic and CT scan images. Our special appreciation goes to Professor Dr. Jolle Kirpensteijn, from Utrecht University, for his valuable advice during the writing of this manuscript.

References

Nasal Rhinosporidiosis in Two Dogs Native to the Upper Mississippi River Valley Region

Two dogs, 4 and 7 years of age, were presented for evaluation and treatment of excessive sneezing. Physical examinations in both cases were within acceptable limits except for the presence of a single mass in the left nasal passage in the first case and left-sided nasal discharge in the second case. Rhinoscopy was used to visualize the nasal masses, and in both cases a single mass was surgically removed. Impression smears and histopathology submitted from each mass revealed lymphoplasmacytic and neutrophilic inflammation with spores typical of Rhinosporidium seeberi. These are the first reported cases of nasal rhinosporidiosis in two dogs native to the Upper Mississippi River Valley area with no travel history outside the region. J Am Anim Hosp Assoc 2010;46:127-131.

Introduction

Rhinosporidium (R.) seeberi is the causative agent of rhinosporidiosis in humans and animals, and it is sporadically reported in parts of the world outside of India, Sri Lanka, and Argentina, where the disease is common.1-3 The organism has recently been classified in the Mesomycetozoea class, near the divergence of animal and fungal boundaries.4 The route of transmission and pathogenesis of rhinosporidiosis are poorly understood; however, the disease has been associated with exposure of moist mucous membranes to wet environments.1-3 The purpose of this case report is to document the diagnosis and treatment of two dogs with nasal polyps caused by rhinosporidiosis. The dogs were native to the Upper Mississippi River Valley area, and they had no travel history to regions in which the disease has previously been reported.

Case Reports

Case No. 1

A 4-year-old, intact male Labrador retriever was referred to the University of Minnesota Veterinary Teaching Hospital for further evaluation of sneezing and a possible nasal foreign body. Initially, the dog was presented to the referring veterinary clinic for sneezing of 5 to 6 weeks’ duration and a mass visible in the left nasal passageway. The dog had a minor episode of epistaxis that resolved spontaneously. Attempts to obtain samples of the nasal mass for cytological diagnosis were unsuccessful, and the dog did not respond to 10 days of treatment with cefpodoxime proxetil.8 The dog lived near lakes and ponds in the Minneapolis-St. Paul metropolitan area. The owner’s property included a pond, and the dog spent a significant amount of time in and around the water. The dog had never traveled outside of the Upper Mississippi River Valley region.

Physical examination on presentation was normal except for the presence of a raised, pinkish-white, polypoid, proliferative mass arising from...
the left nasal septum 1 cm caudal to the nare. While the dog was awake, a cotton-tipped applicator was inserted into the nostril and rubbed against the nasal mass. The applicator was then rolled onto a glass slide, air-dried, and stained with a modified-Romanowsky stain. Cytology revealed a moderate to highly cellular sample with a background of small amounts of blood. Nucleated cells consisted predominately of nondegenerate neutrophils; well-differentiated, nucleated squamous epithelial cells; and occasional mature plasma cells. Numerous magenta-colored, spherical structures (consistent with endospores) were present. They were approximately 6 to 10 µm in diameter with a thick, refractile wall and several round eosinophilic structures inside. The cytological diagnosis was suppurative inflammation with spores typical of *R. seeberi*.

Four weeks after initial examination, the dog was returned for rhinoscopy and mass removal. Presurgical blood work was within normal limits. Rhinoscopy was performed with a 1.9-mm, 0°, rigid endoscope via a transnasal approach. Approximately 1 cm from the nare opening in the left nasal passage, a single, 5- to 7-mm mass was visualized. The mass was grasp with a small, curved, mosquito hemostatic forceps and retracted rostrally. An electrosurgical handpiece with a straight, fine, needlepoint tip was inserted alongside the endoscope, and the base of the mass was transected from the turbinate mucosa using electrocautery. The mass was removed, and the transected margin was further cauterized in an attempt to eliminate any remaining viable organisms associated with the mass. Hemorrhage was minimal, and the dog’s recovery from anesthesia was uneventful.

Impression smears from the surgically removed tissue were of moderate to high cellularity with a background containing small amounts of blood and light eosinophilic, proteinaceous material. Small to moderate amounts of streaming nuclear material and free nuclei were seen. Intact nucleated cells consisted predominately of columnar respiratory epithelial cells that were occasionally hyperplastic in appearance, with plump or rounded cell margins and rare bi- or trinucleation. Moderate anisocytosis and anisokaryosis were present within this population. Also present were moderate numbers of plasma cells, small lymphocytes and nondegenerate neutrophils, and occasional vacuolated macrophages. Numerous magenta-colored spherical structures (endospores) approximately 6 to 10 µm in diameter were observed individually or in small aggregates. The structures were characterized by a thick, refractile wall and several internal, round eosinophilic globular bodies that were typical of *R. seeberi* endospores.

The cytological conclusion from the impression smear was nasal rhinosporidiosis with moderately reactive/dysplastic respiratory epithelial tissue, mixed lymphoplasmacytic and neutrophilic inflammation, and the presence of endospores typical of *R. seeberi*. The findings from the impression smear were similar to the initial cytology from the nasal swab, with minor differences in the types of inflammatory cells and epithelial cells. These differences were likely attributable to the superficial versus deep nature of the sample sources.

Histopathology of the mass demonstrated a proliferative polypoid mass covered by nasal mucosa with abundant, scattered, double-contoured, walled sporangia measuring between 30 and 250 µm in diameter. The larger, mature sporangia contained an abundant number of endospores. Moderate to marked infiltrates of neutrophils, lymphocytes, and plasma cells were also observed, similar to the cytological impression smear. The histological conclusion was a nasal polyp with regionally extensive, severe, subacute rhinitis secondary to *R. seeberi* infection [Figure 1]. Clinical signs resolved immediately after surgical removal of the mass, and the dog remained asymptomatic for over 21 months as of the time of this writing.

**Case No. 2**

A 7-year-old, neutered male Doberman pinscher was referred for treatment of a polyp located in the left nasal passage. Two weeks previously, the dog was presented to the referring veterinarian for a 4-month history of sneezing blood and mucus. Physical examination revealed unilateral left-side nasal discharge. Preanesthetic blood analyses revealed mild lymphopenia (0.5 × 10^3/µL, reference range 1.2 to 5.0 × 10^3/µL), occasional band neutrophils, mild toxic change in segmented neutrophils, and mildly elevated alkaline phosphatase activity (304 U/L, reference range 8 to 140 U/L). The dog was placed under general anesthesia, and radiographs and rhinoscopy were performed by the referring veterinarian. Radiographs showed a 2-cm² soft-tissue...
opacity in the rostral left nasal cavity. Rhinoscopy was performed using a 2.5-mm, rigid handheld rhinoscope via a transnasal approach. A 1 × 3-cm, soft, pink, friable mass was visualized in the rostral left nasal passage. An alligator forceps was used to obtain a biopsy for cytology and histopathology.

A squash preparation made from the sample and stained with a quick stain revealed mixed inflammation and spores consistent with R. seeberi. Histopathology revealed a poly-poid structure diffusely infiltrated with inflammatory cells consisting of neutrophils, plasma cells, lymphocytes, macrophages, and numerous thick-walled sporangia and endospores consistent with R. seeberi. The dog was treated with 10 days of oral amoxicillin trihydrate/clavulanate potassium (562 mg q 12 hours) and carprofen (100 mg q 12 hours) and was referred to the University of Minnesota Veterinary Teaching Hospital for further treatment. The dog lived on acreage with a marshy area in Western Wisconsin, and it had never traveled outside of the Upper Mississippi River Valley region.

At the time of referral, physical examination was within normal limits, with notation of scars on the dog’s muzzle from a previous altercation with a wild animal. Preanesthetic blood work revealed a mildly elevated alkaline phosphatase activity (194 U/L, reference range 8 to 139 U/L) and a normal buccal mucosal bleeding time (3.5 minutes, reference range 1.7 to 4.2 minutes). Rhinoscopy was performed with a 3-mm, flexible endoscope via a transnasal approach. A solitary mass arising from the septum was found in the left nasal cavity approximately 2 cm from the opening of the nare and continuing approximately 2 to 3 cm caudally.

Because of the extent and depth of the mass, a dorsal rhinotomy was dorsal; a rigid handheld rhinoscope via a transnasal approach. A rongeur and curette was used to obtain a biopsy for cytology and histopathology. A squash preparation made from the sample and stained with a quick stain revealed mixed inflammation and spores consistent with R. seeberi. Histopathology revealed a poly-poid structure diffusely infiltrated with inflammatory cells consisting of neutrophils, plasma cells, lymphocytes, macrophages, and numerous thick-walled sporangia and endospores consistent with R. seeberi. The dog was treated with 10 days of oral amoxicillin trihydrate/clavulanate potassium (562 mg q 12 hours) and carprofen (100 mg q 12 hours) and was referred to the University of Minnesota Veterinary Teaching Hospital for further treatment. The dog lived on acreage with a marshy area in Western Wisconsin, and it had never traveled outside of the Upper Mississippi River Valley region.

At the time of referral, physical examination was within normal limits, with notation of scars on the dog’s muzzle from a previous altercation with a wild animal. Preanesthetic blood work revealed a mildly elevated alkaline phosphatase activity (194 U/L, reference range 8 to 139 U/L) and a normal buccal mucosal bleeding time (3.5 minutes, reference range 1.7 to 4.2 minutes). Rhinoscopy was performed with a 3-mm, flexible endoscope via a transnasal approach. A solitary mass arising from the septum was found in the left nasal cavity approximately 2 cm from the opening of the nare and continuing approximately 2 to 3 cm caudally.

Because of the extent and depth of the mass, a dorsal rhinotomy was necessary to ensure adequate excision [Figure 2]. A mosquito hemostatic forceps was inserted in the nasal cavity to the level of the mass to define the appropriate level of exposure. A rostral, left-lateral approach to the nasal cavity was made, just rostral to the nasal incisive bone and extending through the left dorsolateral nasal cartilage. The mass was visualized and measured approximately 5 cm long × 1 cm². The mass and all nasal mucosa in the area of the mass were excised using a rongeur and curette. The area was lavaged and closed in three layers. Hemorrhage was minimal, and the dog’s recovery from anesthesia was uneventful.

Impression smears from the surgically removed tissue were of marked cellularity with a light eosinophilic background containing small numbers of erythrocytes and broken cells [Figure 3A]. The nucleated cell population was predominated by ciliated columnar to plump respiratory epithelial cells. Also present were moderately increased numbers of mixed inflammatory cells consisting mostly of mild to moderately degenerate neutrophils and well-differentiated plasma cells with lower numbers of small mature lymphocytes and occasional vacuolated macrophages. Abundant numbers of deeply basophilic to magenta spherical structures (mature endospores) approximately 4 to 11 µ in diameter were observed, often in small aggregates. The structures had a thick refractile wall, and some endospores had several internal, round eosinophilic structures (eosinophilic globular bodies) arranged concentrically just inside the cell wall [Figure 3A inset]. Some endospores appeared surrounded by a variably thick, clear halo; a thinner cell wall; and eosinophilic globular bodies (consistent with intermediate endospores). Also present were occasional large mats of small (1 to 3 µ), spherical structures. These structures had round, lightly basophilic, stippled centers and a small, deeply basophilic to magenta form, consistent with immature endospores [Figure 3B]. Rare, large (20 to 40 µ), round, deeply basophilic spherical structures with disorganized material within (consistent with immature sporangia) were seen [Figure 3B inset]. All of the forms of endospores and sporangia were consistent with R. seeberi.

The cytological conclusion from the impression smear was nasal rhinosporidiosis with mildly reactive/dysplastic respiratory epithelial tissue, mixed lymphoplasmacytic and neutrophilic inflammation, and the presence of immature, intermediate, and mature endospores and immature sporangia typical of R. seeberi. The sample was also submitted for histopathology, and lymphoplasmacytic and neutrophilic rhinitis with R. seeberi sporangia was diagnosed. Clinical signs resolved after surgical removal of the mass, and the dog remained asymptomatic for 14 months as of this writing.

Discussion

These cases present an unusual diagnosis for nasal polyps in two dogs native to the Upper Mississippi River Valley area. Rhinosporidiosis, caused by R. seeberi, is a condition typically found in tropical areas such as India and Sri Lanka,
After years of controversy on the taxonomy of *R. seeberi*, the organism has been placed in the Mesomycetozoea class, near the divergence of animal and fungal boundaries.\(^1\)\(^\text{-}3\)\(^,\)\(^4\) *Rhinosporidium seeberi* is the only member of Mesomycetozoea that is pathogenic to mammals and birds.\(^4\)

In tissues, endospores develop progressively from juvenile, or trophocyte, to intermediate states and finally form mature sporangia with thousands of endospores, which are then released to reinitiate the cycle.\(^1\)\(^,\)\(^4\) The release of endospores from sporangia occurs after exposure to water; therefore, the disease is associated with wet environments.\(^1\)\(^-\)\(^3\)

However, the natural host, route of transmission, and pathogenesis of rhinosporidiosis are poorly understood.\(^1\)\(^-\)\(^3\)

Recent evidence using 18S rRNA gene sequences suggests multiple host-specific strains of *R. seeberi*.\(^15\) No cases of zoonotic transmission have been reported, although humans are susceptible to disease, as well as dogs, cats, cattle, waterfowl, and horses.\(^1\) In humans, the majority of cases occur in the upper respiratory tract, with lower numbers of cases observed in the skin, subcutaneous tissues, and eyes.\(^1\)

Lesions of rhinosporidiosis in dogs and cats in the United States have only been reported in the nasal cavity.\(^2\)\(^,\)\(^5\)\(^-\)\(^11\)

Diagnosis of rhinosporidiosis is typically accomplished using histopathology or cytology, both of which show typical morphological features of *R. seeberi*, as culture of the organism has been unsuccessful.\(^1\)\(^-\)\(^3\) A polymerase chain reaction assay using *R. seeberi*-specific primers for the 18S rRNA sequence has been developed; however, the assay remains largely used in research settings.\(^4\) *Rhinosporidium* spp. organisms can be stained with a variety of stains including hematoxylin and eosin, Wright, toluidine blue, methenamine, and periodic acid-Schiff.\(^1\)\(^,\)\(^2\)\(^,\)\(^16\)\(^,\)\(^17\)

In cytological samples, sporangia and immature forms of endospores are infrequently found.\(^2\)\(^,\)\(^16\)\(^,\)\(^18\) Cytological descriptions of mature endospores include round eosinophilic to magenta to basophilic structures, 5 to 15 µm in diameter, with internal eosinophilic globules and thick walls.\(^2\)\(^,\)\(^16\)\(^,\)\(^18\) Immature endospores have also been described cytologically as lightly basophilic, spherical structures that are 2 to 4 µm in diameter, with a paracentral light pink-purple area and one to two smaller, spherical, dark-purple structures.\(^2\) A mixed inflammatory response of plasma cells, small lymphocytes, and neutrophils is typical.\(^16\)

Histopathological features include fibrous tissue, granulomatous inflammation, and sporangia. These are further classified as juvenile (15 to 75 µm with a single nucleus) or mature (100 to 400 µm with numerous endospores).\(^3\)

Differential diagnoses on cytological and histological samples include *Coccidioides immitis* and *Cryptococcus neoformans*, based on slight morphological similarities and staining characteristics. However, diagnosis of rhinosporidiosis typically only requires cytological or histological identification.\(^1\)\(^,\)\(^2\)\(^,\)\(^17\)

Clinical signs of rhinosporidiosis in animals relate to single or multiple polyps in the nasal cavity and associated inflammation. White-yellowish foci can be observed on the surface of the polyp, and they represent sporangia.\(^1\)

---

**Figures 3A, 3B**—Case no. 2: Cytology samples of an impression smear made from a nasal polyp in a dog (Modified-Romanowsky stain). (A) Mature *Rhinosporidium seeberi* endospores (arrow) with intermediate endospores (arrowhead) (50× objective, bar=10 µm). Inset: Eosinophilic globular bodies (arrow) inside mature endospores (100× objective, bar=5 µm). (B) A large mat of immature endospores (top) is present, along with mature endospores (arrow) (100× objective, bar=10 µm). Inset: Intermediate sporangia (50× objective, bar=10 µm).

Argentina, and sporadically in other areas.\(^1\)\(^-\)\(^3\) In the United States, the majority of the cases are reported in the south-eastern and south central states and as far north as Missouri.\(^2\)\(^,\)\(^5\)\(^-\)\(^13\) One case of a dog in Ontario, Canada, has been reported.\(^14\)
treatment of choice is surgical excision, preferably with electrocautery, because antifungal and antibacterial agents are not effective.\textsuperscript{1,2} Dapsone, a sulfone anti-infective drug that appears to stop the maturation of the sporangia, has been used in humans as an adjunct to surgical removal.\textsuperscript{1,2} However, recurrence of disease is not uncommon.\textsuperscript{1,2}

**Conclusion**

This is the first case report of nasal rhinosporidiosis in two dogs in the Upper Mississippi River Valley region. Diagnoses were made based on cytological samples and were confirmed with histopathology. Treatment consisted of surgical removal of the masses, and the dogs have been free of clinical signs of the disease for 21 and 14 months, respectively. Although rare, rhinosporidiosis should be included on differential lists for a nasal polyp, especially if the animal is commonly exposed to wet environments.

**Footnotes**

\textsuperscript{a} Simplicef; Pfizer Animal Health, Exton, PA 19341  
\textsuperscript{b} Quick III Solution; Astral Diagnostics, Inc., West Deptford, NJ 08066  
\textsuperscript{c} Clavamox; Pfizer Animal Health, Exton, PA 19341  
\textsuperscript{d} Rimadyl; Pfizer Animal Health, Exton, PA 19341

**References**

Intraaxial Spinal Cord Hemorrhage Secondary to Atlantoaxial Subluxation in a Dog

A 1-year-old, 3.5-kg, spayed female, toy poodle was presented for acute-onset tetraplegia and neck pain. Neuroanatomical diagnosis was consistent with a first through fifth cervical (C1 through C5) spinal cord lesion. Radiographs of the cervical vertebral column revealed atlantoaxial (AA) subluxation. Magnetic resonance imaging revealed abnormalities consistent with intraaxial spinal cord hemorrhage at the level of the AA articulation. The dog was treated with external coaptation. After 8 days, the dog regained voluntary motor function in all four limbs. Surgical stabilization was pursued. Postoperatively, the dog regained the ability to ambulate. This report details the imaging findings and management of a dog with intraaxial spinal cord hemorrhage secondary to AA subluxation. J Am Anim Hosp Assoc 2010;46:132-137.

Introduction

Atlantoaxial (AA) subluxation is encountered most often in small-breed dogs, particularly Yorkshire terriers, Chihuahuas, and miniature poodles;1-3 however, any breed can be affected.4,5 The clinical presentation may be acute or chronic, with clinical signs ranging from mild cervical pain or tetraparesis to tetraplegia, respiratory compromise, and death.2 Atlantoaxial subluxation results in caudal and dorsal displacement of the axis in relation to the atlas and flexion of the AA joint, which may cause compression and concussion of the spinal cord.2 The typical cause of AA subluxation is loss of the ligamentous intervertebral support, which often coincides with a congenital malformation of the dens.6-8 Trauma to the cranial cervical vertebralcolum n may also result in AA subluxation secondary to fracture of the dens or ligamentous rupture.9

Atlantoaxial subluxation is often diagnosed radiographically.6 The typical radiographic features include: increased distance between the spinous process of the axis and the dorsal arch of the atlas; dorsal displacement of the body of the axis into the vertebral canal; and absence, agenesis, or dorsal deviation of the dens.2,4,8 When not obvious, flexion of the neck will often make the subluxation more apparent; however, flexion can lead to further spinal cord injury.2 Computed tomography (CT) or CT combined with myelography can be used to identify spinal cord compression and provide accurate evaluation of the dens.2 Magnetic resonance imaging (MRI) can be used to evaluate the vertebrae and to identify spinal cord compression. Magnetic resonance imaging is particularly sensitive for the identification of intraaxial spinal cord abnormalities. To date, no study has detailed the MRI appearance of AA subluxation in dogs. In this report, the MRI findings and management of a dog with AA subluxation are detailed. In addition to the AA subluxation, abnormalities were observed within the spinal cord that were compatible with intraaxial spinal cord hemorrhage.

Case Report

A 1-year-old, 3.5-kg, spayed female, toy poodle was presented for acute-onset tetraplegia and severe neck pain. Although the owners did not observe a traumatic incident, the dog was unsupervised prior to being...
found recumbent and vocalizing. The dog had no previous medical problems.

Physical examination revealed only tachycardia and tachypnea, considered to be a response to pain. On neurological examination, the mentation was normal. The dog was tetraplegic except for occasional voluntary movement of the right pelvic limb. Postural reactions were absent in all four limbs. Myotatic and withdrawal reflexes were normal in all four limbs. The cutaneous truncal reflex was normal. Muscular tone was increased in all four limbs. The dog would vocalize in pain with minimal handling and with any movement of the neck. Neuroanatomical diagnosis was consistent with a first through fifth cervical vertebrae (C1 through C5) spinal cord lesion. Differential diagnoses included AA subluxation, vertebral fracture, diskospondylitis, meningo(myel)itis, and intervertebral disk disease.

Diagnostic testing included a complete blood count, serum biochemical profile, and urinalysis, all of which were normal. A lateral radiograph of the cervical vertebral column was obtained in a neutral position and demonstrated dorsal displacement of the second cervical vertebra (C2). The dorsal displacement of the body of the axis in relation to the atlas created an increased distance between the dorsal arch of the atlas and the spinous process of the axis. These radiographic findings were consistent with AA subluxation. Ventrodorsal and oblique radiographs were not performed. Given the severity of the neurological deficits, MRI was performed to assess the compression and parenchymal changes of the spinal cord secondary to the AA subluxation. Under anesthesia, MRI of the cervical vertebral column was performed using a 3.0T MR unit with an extremity (knee) coil. The dog was placed in dorsal recumbency with the neck in a neutral to slightly extended position. The following pulse sequences were performed: T1-weighted fluid-attenuated inversion recovery (T1W FLAIR), T2-weighted (T2W), T2*-weighted (T2*W), T2-weighted fluid-attenuated inversion recovery (T2W FLAIR), and two-dimensional multiple-echo recalled gradient echo (2D-MERGE). The T1W FLAIR images were obtained after intravenous (IV) administration (0.2 mL/kg) of gadopentetatedimeglumine. Images were obtained in the sagittal, axial, and dorsal planes.

In the sagittal plane images, dorsal subluxation of the vertebral body of the axis in relation to the atlas was noted. The spinous process of the axis was difficult to visualize, which made it difficult to appreciate the increased distance between the spinous process of the axis and the dorsal arch of the atlas. However, ventrally the distance between the body of C1 and the dens appeared (subjectively) enlarged [Figure 1]. The dens also appeared (subjectively) hypoplastic in the sagittal and dorsal plane images. The ventral and dorsal subarachnoid space was attenuated in the sagittal and axial plane images. In the sagittal plane, the spinal cord was deviated dorsally and was dorsoventrally compressed by the cranial aspect of the axis and dens as a result of the AA subluxation. An intraaxial, linear spinal cord lesion was identified extending from the midbody of the atlas to the caudal body of the axis in the dorsal funiculus.

The lesion was hypointense (signal void) on T1W FLAIR, T2W, T2W FLAIR, T2*W, and 2D MERGE images [Figures 2A, 2B]. The signal void was most evident in the sagittal and axial planes. On T2W and T2W FLAIR images, the hypointense spinal cord lesion was surrounded by an area of hyperintensity [Figure 3]. Contrast enhancement was not noted. In addition to AA subluxation, the imaging findings were consistent with intraaxial spinal cord hemorrhage and edema at the level of the AA articulation. Following MRI, cerebrospinal fluid was collected from the fifth and sixth lumbar (L5 to L6) intervertebral site. Cerebrospinal fluid analysis was normal.

Based on the MRI findings and the dog’s severe neurological deficits, the prognosis for full neurological recovery was considered to be guarded; therefore, the dog was treated conservatively for 7 days, limiting exacerbation of the concussive injury while monitoring for neurological improvement to enable a more accurate prognostic assessment prior to pursuing surgical stabilization of the joint. Conservative management consisted of external coaptation of the head and neck from the rostral mandible to the cranial thorax, as described previously. In addition, the dog was administered buprenorphine (0.005 mg/kg IV q 8 hours), IV fluid therapy, and prednisone (0.5 mg/kg per day per os). Neurological deficits gradually improved, and 8 days after initial presentation, the dog had voluntary motor function in all four limbs but remained nonambulatory.

With the improvement suggestive of a more favorable prognosis, surgical stabilization was performed via a modified...
ventral fixation technique using cortical screws, Kirschner wires, and polymethylmethacrylate. Postoperative radiographs disclosed adequate alignment and fixation. Five days postoperatively, the dog was able to ambulate with minimal assistance. Seven days postoperatively, on the day of discharge, the dog was ambulatory but had a severe proprioceptive ataxia and tetraparesis. Fourteen days postoperatively, the dog was ambulatory with a mild proprioceptive ataxia. Two months postoperatively, the neurological examination was normal.

Discussion
Treatment of AA subluxation consists of either conservative management or surgical stabilization. Although numerous risk factors affecting the prognosis of AA subluxation have been assessed, only age at onset and duration of clinical signs have been associated with prognosis. Specifically, affected dogs <2 years of age and with a duration of clinical signs <10 months were associated with a positive outcome following surgical stabilization. Similarly, when treated conservatively, affected dogs with a duration of clinical signs <30 days were significantly more likely to have a positive outcome. The dog reported here initially was treated conservatively with external coaptation to temporarily stabilize the AA joint until the dog showed signs of improvement. Conservative management was selected initially in order to more accurately predict whether a positive outcome could be expected following surgical stabilization.

We hypothesized that the neurological deficits were due primarily to spinal cord concussion and the associated hemorrhage and edema rather than the ongoing spinal cord.
compression or vertebral instability. In AA subluxation, vertebral instability is a chronic lesion (despite the frequent acute presentation of affected animals) that is often the result of minor trauma leading to concussive injury of the spinal cord. In the case reported here, external coaptation was initially utilized to eliminate instability and prevent continued concussive injury to the spinal cord. By doing so, it was believed that resolution of the hemorrhage and edema in the spinal cord would occur, clinical improvement could be observed, and the need for an immediate stabilization surgery would be eliminated. Such case management is contraindicated in severely affected dogs with acute intervertebral disk herniation, in which time to surgical intervention is correlated with return to function. Likewise, in cervical vertebral fractures, the shorter the time to surgical intervention the better the prognosis. In both of these latter disease processes (i.e., intervertebral disk herniation and cervical vertebral fracture), compressive and concussive forces occur acutely and lead to secondary spinal cord injury. Immediate decompressive surgery is advisable in cases in which acute compressive injury underlies the pathophysiology of the spinal cord injury.

Acute traumatic injury to the spinal cord leads to pathological changes in the spinal cord that may not respond to surgery alone. In chronic diseases such as caudal cervical spondylomyelopathy (Wobbler syndrome), vertebral instability leads to chronic pathological changes in the spinal cord including demyelination, neuronal loss, and gliosis. As a result, though prompt surgical intervention should be strongly considered in severely affected dogs with chronic vertebral instability, the need for immediate surgical intervention is unknown. While definitive recommendations cannot be ascertained from a single case, initial conservative treatment of spinal cord hemorrhage and edema secondary to AA subluxation in the severely affected dog reported herein provided the clinicians valuable prognostic information. A positive outcome was predicted prior to pursuing surgical stabilization.

In this case, the intraaxial spinal cord lesion was observed in the spinal cord that was hypointense (signal void) on spin-echo and gradient-echo sequences. Signal voids on spin-echo sequences are associated with gas, cortical bone, calcification, fibrous tissue, metallic implants, fast-flowing blood, and blood breakdown products. Based on the acute onset of neurological deficits and the presence of the AA subluxation and consequent spinal cord compression, the hypointensity in the dorsal funiculus was assumed to be associated with blood breakdown products. Findings on both of the gradient-echo sequences (T2*W and 2D MERGE) supported the presumptive diagnosis of intraaxial spinal cord hemorrhage.

Similar to other pulse sequences, gradient-echo sequences utilize a radiofrequency (RF) pulse for the conversion of longitudinal magnetization into transverse magnetization. Immediately after the RF pulse, protons that are in phase begin to dephase as a result of four effects: spin-spin interactions, chemical shift effects, magnetic inhomogeneities, and magnetic susceptibility differences. Spin-spin interactions refer to the effect one proton has on a neighboring proton. The chemical shift effect is the difference in the precessional frequency of water protons compared to fat protons. Magnetic inhomogeneities reflect that the main magnetic field is never uniform. Finally, magnetic susceptibility refers to the effect a material or tissue has on the main magnetic field.

Most tissues in the body are diamagnetic, essentially nonmagnetic, and they weaken the main magnetic field. Paramagnetic substances (such as the gadolinium-containing MRI contrast agents) become magnetized in an external magnetic field, and they strengthen the main magnetic field. Ferromagnetic materials, such as iron, are permanently magnetic and tend to greatly increase the main magnetic field. When two tissues of greatly different magnetic susceptibilities are adjacent (such as the bone/fat interface of the vertebræ and epidural fat), strong local variations in the magnetic field are created, resulting in a heterogeneous magnetic field causing an artifact (magnetic susceptibility artifact). When dephasing is the result of only spin-spin interactions, it is referred to as T2 decay. However, when dephasing is the result of all four effects, it is referred to as T2*. Unlike spin-echo sequences, gradient-echo sequences utilize gradients to rephase protons after the application of the initial RF pulse. Since gradients do not correct the effects of chemical shift, magnetic field inhomogeneities, and magnetic susceptibility, all four factors contribute to dephasing in gradient-echo images. While these sequences are inherently prone to artifacts, this creates an advantage for hemorrhagic lesions because of the paramagnetic and ferromagnetic nature of blood breakdown products. The paramagnetic and ferromagnetic nature of blood breakdown products results in increased local dephasing, causing magnetic susceptibility artifacts that ultimately lead to signal void on T2*-weighted images.

In the present case, 2D-MERGE was used to evaluate the spinal cord. As with other multiple-echo gradient-echo sequences, the 2D-MERGE acquires multiple echoes with four different echo times, and they are averaged together, decreasing magnetic susceptibility artifacts. Increasing the bandwidth also reduces chemical shift and magnetic susceptibility artifacts. Two-dimensional multiple-echo gradient-echo sequences use large bandwidths to minimize magnetic susceptibility artifacts; this adversely affects image quality of the vertebral column. However, the magnetic susceptibility artifacts related to hemorrhage remain apparent.

In veterinary medicine, the use of T2*W imaging is limited. While T2*W sequences are utilized in the evaluation of hemorrhagic lesions, other substances such as ferritin, calcium, metallic material (surgical implants or metallic particles postoperatively from surgical drills), and air also result in a marked loss of signal. Based on the signalment and diagnosis of AA subluxation, the signal void within the cranial cervical spinal cord was assumed to be hemorrhage.
In acute spinal cord injury (SCI) in humans, MRI of the spinal cord has largely supplanted the use of other imaging modalities. Several imaging characteristics have been observed with acute SCI in humans. In acute SCI, hyperintensity on T2W images within the spinal cord is thought to be edema, whereas hypointense lesions typically represent hemorrhage. As seen in the dog reported here, a hypointensity surrounded by peripheral hyperintensity in the spinal cord on T2W images likely represents hemorrhage with associated peripheral edema. With acute SCI, the findings of spinal cord edema, swelling, and hemorrhage are associated with the severity of the neurological impairment in humans. In one study, intraxial spinal cord hemorrhage was always associated with absence of sensory and motor function; however, in other studies, intraxial spinal hemorrhage was also observed in conjunction with less severe neurological deficits. Similarly, spinal cord edema and swelling also were observed in cases with preserved sensory or motor function. Although the severity of clinical signs associated with hemorrhage in the spinal cord has not been evaluated in dogs, intraxial spinal cord hyperintensity on T2W images may influence the prognosis in dogs with intervertebral disk herniations.

In humans with acute SCI, a poor prognosis has been correlated with spinal cord abnormalities observed with MRI. Specifically, a poor prognosis has been associated with intraxial hemorrhage in the spinal cord. However, the effect of spinal cord edema or swelling on prognosis in humans with acute SCI remains unclear. Dogs lacking nociception and having a hyperintensity in the spinal cord on T2W images had a postoperative success rate of 33%. Furthermore, dogs lacking nociception and having a hyperintensity length >3 times the length of the second lumbar (L2) vertebra had only a 10% postoperative success rate compared to a 100% postoperative success rate in dogs lacking nociception without a hyperintensity in the spinal cord. In the dog presented here, the intraxial spinal cord hemorrhage did not have a negative impact on outcome. Postoperatively, the dog recovered the ability to ambulate, and at the 2-month postoperative follow-up, the neurological examination was normal.

**Conclusion**

The signalment, history, and neurological signs of the dog in this report were consistent with AA subluxation. Magnetic resonance imaging evaluation of the cervical vertebral column correlated with the clinical and radiographic findings; however, noting the dorsal displacement of the body of the axis in relation to the body of the atlas was more helpful in the diagnosis of AA subluxation than observing the distance between the dorsal arch of the atlas and spinous process of the axis. In addition to observing the AA subluxation, intraxial spinal cord pathology was noted. Findings were compatible with intraxial spinal cord hemorrhage. The T2*W images were helpful in identifying a signal void in the spinal cord that was compatible with hemorrhage. In the future, MRI may be utilized in dogs suspected of AA subluxation in order to assess the spinal cord for evidence of edema or hemorrhage. Finally, initial conservative management of AA subluxation in select cases of severely affected dogs may provide valuable prognostic information prior to pursuing surgical stabilization.

**Footnotes**


**References**

Spontaneous Feline Pneumothorax Caused by Ruptured Pulmonary Bullae Associated With Possible Bronchopulmonary Dysplasia

Spontaneous pneumothorax is rarely reported in the cat. This case report describes the use of computed tomography (CT) to diagnose pulmonary bullae in an adult cat with recurrent spontaneous pneumothorax. A large bulla in the right middle lung lobe and several blebs in other lobes were identified by CT. Partial lobectomy of the right middle and right and left cranial lung lobes was successfully performed to remove the affected portions of lung. Histopathological examination suggested bronchopulmonary dysplasia (BPD) as the underlying cause for development of the pulmonary bulla. This is the first case report in the veterinary literature describing the use of CT to identify pulmonary bullae in the cat with BPD as a possible underlying cause. J Am Anim Hosp Assoc 2010;46:138-142.

Marjorie E. Milne, BVSc (Hons), MACVSc
Christina McCowan, MACVSc
Ben P. Landon, BVSc, MACVSc, FACVSc

Introduction

Spontaneous pneumothorax is the accumulation of air within the pleural space without underlying trauma. In the dog, the most common cause of spontaneous pneumothorax is rupture of emphysematous bullae; however, the underlying cause for bulla formation usually is not reported. Spontaneous pneumothorax is less commonly reported in the cat. Implicated diseases are parasitic infection, feline asthma, and eosinophilic small airway inflammation. A diagnosis of pneumothorax is readily made on thoracic radiography. The lungs should be evaluated for underlying pulmonary parenchymal disease. Pulmonary bullae appear as circular, lucent cavities with thin walls; however, other differentials such as pneumatoceles or bronchial cysts should also be considered. Smaller blebs are not often seen. Radiography is known to be unreliable in the diagnosis of pulmonary bullae or blebs. In humans, computed tomography (CT) is considered the imaging modality of choice for the detection of pulmonary bullae and blebs, and a recent publication has supported similar findings in dogs. In addition, CT provides valuable information to assist surgical planning.

To our knowledge, this is the first description of the use of CT to diagnose pulmonary bullae in a cat with recurrent spontaneous pneumothorax. This is also the first reported case of possible bronchopulmonary dysplasia (BPD) as an underlying cause of feline pulmonary bulla formation.

Case Report

A 3-year-old, neutered male, domestic longhaired outdoor cat was presented to the referring veterinarian with sudden-onset respiratory distress. Thoracic radiographs revealed a pneumothorax, and thoracocentesis drained 70 mL of air. The cat was referred to an emergency center for further care.
On presentation to the emergency care center, the cat had a heart rate of 204 beats per minute with a respiratory rate of 120 breaths per minute. Mucous membranes were pink with a normal capillary refill time, and the temperature was 38.9°C. Thoracic auscultation identified reduced breath sounds on the right side. No evidence of external trauma was seen. The cat was sedated with butorphanol\(^a\) (0.22 mg/kg) and diazepam\(^b\) (0.22 mg/kg) administered intravenously (IV), and percutaneous needle thoracocentesis removed 250 mL of air from the right hemithorax and only a minimal volume of air from the left hemithorax. The cat was placed on oxygen supplementation, and once it was stable, thoracic radiography\(^c\) was performed. Radiographs revealed alveolar changes in the left cranial and right caudal lung lobes, suggestive of pulmonary hemorrhage or contusion. Traumatic pneumothorax was suspected despite the absence of a history and any physical evidence of trauma. The cat remained stable and was discharged from the hospital 1 day after presentation.

The cat was presented again to the emergency center for recurrent respiratory distress 1 day after discharge. Respiratory rate was 80 breaths per minute with increased respiratory effort and reduced respiratory sounds on the right side. Repeat thoracic radiographs confirmed reoccurrence of the pneumothorax, but this time it was bilateral with alveolar changes and collapse of all lobes, attributed to atelectasis. Thoracocentesis removed 200 mL of air from the right side of the thorax and 50 mL from the left. The cat was discharged after overnight observation, and owners were instructed to restrict the cat’s activity and have thoracic radiography repeated after 48 hours.

Ten days later, owners presented the cat with dyspnea and a respiratory rate of 80 breaths per minute. Thoracic radiography identified elevation of the heart from the sternum and collapse of lung lobes, with scalloping of the diaphragm, which indicated a tension pneumothorax. Thoracocentesis removed 150 mL of air from the right side and 75 mL from the left side. At this stage, spontaneous pneumothorax was suspected, and thoracic CT was performed to further investigate an underlying cause.

The cat was premedicated with buprenorphine\(^d\) (0.015 mg/kg subcutaneously [SC]), and anesthesia was induced with propofol\(^e\) (5 mg/kg IV) and maintained with isoflurane\(^f\) in oxygen, delivered by a Bain nonrebreathing system with intermittent positive-pressure ventilation. A median sternotomy was performed from and including the second sternebra to the xiphoid process, using a pneumatic oscillating saw. A large pulmonary bulla was readily identified at the periphery of the right middle lung lobe [Figure 1]. Smaller blebs were identified at the caudal aspect of the left cranial lung lobe and at the caudal aspect of the right cranial lung lobe.

Partial lobectomies of the right middle, right cranial, and the caudal portion of the left cranial lung lobe were performed. The right middle lung lobe was stapled with a TA 55 linear stapler,\(^k\) while the right cranial and left cranial lung lobes were closed with a continuous overlapping suture with acepromazine\(^h\) (0.02 mg/kg) and morphine\(^i\) (0.3 mg/kg) SC. Anesthesia was induced with alfaxalone\(^j\) (1.5 mg/kg IV) and maintained with isoflurane\(^f\) in oxygen, delivered by a Bain nonrebreathing system with intermittent positive-pressure ventilation. A median sternotomy was performed from and including the second sternebra to the xiphoid process, using a pneumatic oscillating saw. A large pulmonary bulla was readily identified at the periphery of the right middle lung lobe [Figure 1]. Smaller blebs were identified at the caudal aspect of the left cranial lung lobe and at the caudal aspect of the right cranial lung lobe.

Partial lobectomies of the right middle, right cranial, and the caudal portion of the left cranial lung lobe were performed. The right middle lung lobe was stapled with a TA 55 linear stapler,\(^k\) while the right cranial and left cranial lung lobes were closed with a continuous overlapping suture

---

**Figure 1**—Computed tomography image of the thorax, showing air-filled bulla (arrow) at the apex of the right middle lung lobe.

**Figure 2**—Intraoperative photograph showing pulmonary bulla (arrow) at the apex of the right middle lung lobe.
of 4-0 polydioxanone followed by a simple continuous suture of 4-0 polydioxanone. No leaks were detected from either the staple or suture lines following saline infusion of the thoracic cavity. Saline was suctioned from the thoracic cavity, and a 10-French thoracostomy tube was placed in the right hemithorax. The sternum was closed with an overlapping figure-of-eight pattern using 1 polydioxanone sutures. The ventral thoracic musculature was closed with a continuous suture pattern of 2-0 polydioxanone. Subcutaneous tissue was closed with 3-0 continuous suture, and the skin was closed with 3-0 nylon interrupted sutures.

Lung samples were submitted for histopathological evaluation and showed abnormal alveolar structures at the periphery of the lobes, with clusters and bilayered cords of plump cells generally resembling type II pneumocytes. Cells had poorly defined borders and variably sized nuclei [Figure 3]. Occasional binucleated cells were seen. Clusters of these pneumocyte-like cells were sometimes associated with a collagenous core, but Masson’s trichrome and reticulin staining confirmed that, in general, the collagenous and elastic elements of the alveolar septa were absent [Figures 4A, 4B]. The spaces between clusters of pneumocyte-like cells were variably sized, ranging from channels reminiscent of respiratory bronchioles that have not produced alveoli to large and irregular bullae. Focal scarring of the pleural surface was present in the region of the largest bullae, and acute hemorrhage was seen on the pleural surface and within the parenchyma at the tip of one lung lobe. Some alveolar cells contained pale golden-brown pigment, confirmed by Perl’s Prussian blue staining to be hemosiderin, which indicated previous episodes of hemorrhage. Larger bronchioles at the margins of the more normal tissue were themselves normal in structure, with no evidence of mucostasis or other obstruction, and no abnormalities were apparent in the local blood vessels. A few focal accumulations of lymphocytes were in the parenchyma, including intraluminal alveolar macrophages and small numbers of mixed inflammatory cells (neutrophils and lymphocytes) in the air spaces.

Postoperative medical care consisted of supportive therapy including IV fluids, analgesia with bupivacaine (1.1 mg/kg) instilled through the chest drain q 4 hours, and morphine (0.3 mg/kg SC) as required. The bupivacaine and morphine were later replaced by buprenorphine (0.01 mg/kg SC q 8 hours) starting 36 hours postsurgically. The chest drain was removed approximately 36 hours after surgery. The cat remained stable and was discharged from the hospital on the third day. A postoperative examination 10 days after surgery showed a normal breathing pattern and thoracic auscultation. At a follow-up examination 2 months after surgery, the cat was well and had no signs of respiratory difficulties.

Discussion
In humans, spontaneous pneumothorax is classified as either primary or secondary. Primary spontaneous pneumothorax occurs in patients who are otherwise healthy with no microscopic evidence of pulmonary disease; patients are
most commonly young, ectomorphic men. Spontaneous pneumothorax may result from a pulmonary collagen defect leading to formation of small, subpleural blebs or bullae that rupture. \(^{10}\) Cigarette smoking has been identified as a risk factor for primary spontaneous pneumothorax in people. \(^{11}\)

In two reported case series of spontaneous pneumothorax in dogs, 38% to 68% of these cases were caused by rupture of pulmonary bullae or blebs for which an underlying cause was not identified. \(^{1,3}\) In addition to rupture of pulmonary bullae or blebs, other causes of spontaneous pneumothorax reported in dogs included neoplasia, migration of plant awns, bacterial pneumonia, parasitic granulomas, mycotic granuloma, \textit{Dirofilaria immitis} infection, lung abscesses, and canine asthma. Although less widely reported in cats, spontaneous pneumothorax appears to be associated with parasitic infection, feline asthma, and eosinophilic small airway inflammation. In these cases, histological evidence is sparse, and feline spontaneous pneumothorax associated with rupture of pulmonary bullae does not appear to have been reported. \(^{4-7}\)

The proposed pathogenesis behind pulmonary bulla formation has changed over time. An earlier report postulated that the formation of pulmonary bullae in the dog was due to obstruction of small airways creating a valvular mechanism that caused air to be trapped and the lung to over-inflate. A pulmonary collagen defect also has been suggested to possibly permit bulla formation. \(^{12}\) In human patients, a valvular mechanism was not identified. Instead, bullae were proposed to develop after retraction and collapse of surrounding lung away from regions of weakness. \(^{13}\) Other theories involve the presence of biochemical and collagen abnormalities, \(^{14}\) and more recent work correlates pulmonary bulla formation with BPD.

Bronchopulmonary dysplasia is a term that has undergone some change with time. Early definitions describe the condition in human infants associated with prematurity, acute lung injury, and aggressive ventilation. With increased survival of neonates with BPD, the definition has been expanded to encompass chronic lung disease resulting from incomplete or inappropriate repair of inflamed and injured lung tissue. Bronchopulmonary dysplasia results in marked enlargement of distal air spaces, but, unlike chronic obstructive pulmonary disease, BPD results from disruption of normal lung development, not from destruction of established alveoli. Impairment of either alveolar formation or development of pulmonary capillaries can lead to minimal alveolar wall fibroproliferation, and the abnormal development of alveoli leads to the formation of emphysematous bullae and blebs. \(^{17}\)

Long-term pulmonary dysfunction is seen in children who survive neonatal BPD, despite gradual improvement in respiratory function and radiological parameters. \(^{18}\) Lesions are best visualized with CT and are characterized by multiple areas of hyperaeration, linear opacities underlying triangular subpleural opacities (which are visible on several consecutive sections), and no bronchiectasia. \(^{18}\) A recent study following 21 survivors of BPD to adulthood found that 84% of patients had emphysema, identified by CT. \(^{19}\)

Clinical reports of BPD-like disease in the veterinary literature are few. Bronchial cartilage dysplasia and lobar emphysema are reported by several authors, \(^{20-23}\) in addition to one case report of bronchial dysgenesis leading to lobar emphysema in a cat. \(^{24}\) The case of the cat is unusual in that the bronchial dysgenesis affected all lung lobes except the emphysematous lobe.

The histopathological findings for the case presented in this report suggest that emphysematous regions of lung may have been associated with abnormal alveolar development. An alternate, albeit less likely, possibility is that inflammation resulted in type II pneumocyte hyperplasia, atelectasis, and secondary emphysema with bullae formation. In the cat presented herein, two possibilities are proposed: 1) the developing epithelium in the affected lobes failed to provide the required signal for vascular endothelial proliferation, or 2) peripheral vessels in the three affected lung lobes failed to appropriately signal to the epithelium to differentiate into normal alveolar structures. The result has been an apparently local dysplasia, and, while the complete normality of the remaining lung lobes cannot be guaranteed, no clinical or radiographic evidence suggests involvement of the entire organ.

Thoracic CT is extremely valuable in cases of spontaneous pneumothorax, both from a diagnostic standpoint and in assisting with surgical planning. In a study involving 12 dogs, Au et al found that although radiographs were 100% sensitive in detecting pneumothorax, they were poor in revealing the underlying cause. \(^{9}\) Computed tomography examination identified bullae or blebs in nine dogs, and the correlation was good between identification of the affected lobes by CT and surgical exploration. The use of CT in the cat presented in this report allowed identification of pulmonary blebs in both the left and right sides of the thorax, which indicated a median sternotomy approach was necessary to remove the affected portions of lung. Spontaneous pneumothorax may be treated medically with thoracocentesis, placement of a thoracostomy tube, and confinement; however, recurrent or persistent pneumothorax, or the presence of bullae or blebs, warrants surgical intervention. Studies have shown that dogs with spontaneous pneumothorax that are managed surgically have lower recurrence and mortality rates compared to dogs managed medically. \(^{1,3}\)

**Conclusion**

Spontaneous pneumothorax is rare in cats, and most documented cases are associated with underlying chronic pulmonary disease. This is the first case report of recurrent, spontaneous pneumothorax as a result of possible BPD in a cat. Continuing on from the human literature, this report also provides an explanation for the development of emphysematous bullae. In this case, CT proved extremely useful in the diagnosis of pulmonary bullae, and it assisted in surgical planning. Computed tomography should be considered in the investigation of cases of spontaneous pneumothorax, particularly when underlying pulmonary disease is not suspected.
Footnotes

a Dolorex; Intervet Australia Pty Ltd, Bendigo East, Victoria, 3550 Australia
b Pamlin; Parnell Laboratories (Aust) Pty Ltd, Alexandria, New South Wales, 2015 Australia
c Fujifilm Computed Radiography; Fujifilm Australia, Brookvale, New South Wales, 2100 Australia
d Temgesic; Reckitt Benckiser, West Ryde, New South Wales, 2114 Australia
e Rapinovet; Schering-Plough Animal Health, North Ryde, New South Wales, 2113 Australia
f I.S.O. Inhalation Anaesthetic; Veterinary Companies of Australia Pty Ltd, Blacktown BC, New South Wales, 2148 Australia
g X Vision CT scanner; Toshiba, Minato-ku, Tokyo, 105-8001 Japan
h ACP2 Injection; Delvet Pty Ltd, Seven Hills, New South Wales, 2147 Australia
i DBL Morphine Tartrate; Mayne Pharma Pty Ltd, Mulgrave, Victoria, 3170 Australia
j Alfaxan-CD RTU; Jurox Pty Ltd, Rutherford, New South Wales, 2320 Australia
k Auto Suture Company; USSC, Norwalk, CT 06856

References

Follicular Dysplasia of the Adult Doberman Pinscher

This paper presents the case of an adult female, red Doberman pinscher affected by permanent hypotrichosis, limited to the dorsolumbar region and sides of the trunk. The hypotrichosis began at approximately the age of 2 years and progressed slowly with no skin hyperpigmentation. The clinical and histopathological characteristics are of an uncommon form of follicular dysplasia. J Am Anim Hosp Assoc 2010;46:143-147.

Introduction

Follicular dysplasia is the generic name for a group of cutaneous diseases characterized by an imperfect development of the hair follicle. Follicular dysplasia is clinically manifested by abnormal or fragile hair shafts, which may result in hypotrichosis or alopecia, the location of which varies according to the type of dysplasia and the affected breed.\(^1^\)-\(^3\)

In 1990, Miller described a type of follicular dysplasia in four black and two red Doberman pinschers; the condition was considered to be a rare and characteristic type of genodermatosis.\(^4\) These dogs showed progressive loss of hair, which began in adulthood and slowly progressed to areas of alopecia limited to the dorsolumbar region and the flanks. At a histological level, these Doberman pinschers had orthokeratotic hyperkeratosis, follicular dilatation, peribulbar melanophages, and pigmentary alterations; however, sebaceous glands and arrector pili muscles were normal. In all six dogs, the pigmentary alterations were due to melanin aggregates in the cortex of the hair shafts; in three cases, free melanin aggregates were present in the hair follicles.

Since the Miller report was published 2 decades ago, no new cases of this dysplasia appear to have been reported. Herein, we report a case of follicular dysplasia in a Doberman pinscher that had clinical and histopathological aspects similar to those described by Miller.\(^4\)

Case Report

Medical History and Clinical Findings

In August 1996, an intact female, 4-year-old, red Doberman pinscher with an unknown family history was presented for examination of a mammary nodule. No history of any health problems (except for loss of hair in the lumbar region and flanks, producing areas of hypotrichosis) was reported. The dog lived in a clean environment and was housed primarily outdoors in a geographic region (southern Brazil) with well-defined seasons. The dog was fed a high-quality commercial dog food and received all routine vaccinations on a yearly basis. No imbalance of the estrous cycle or any signs of abnormal behavior were seen, and the dog was active and had a docile nature. The loss of hair had begun at approximately 2 years of age and progressed slowly, with some episodes of scaling. During visits to other veterinarians, the possibility of a hormonal disorder had been raised; however, attempts at recognized treatments had no effect, and the owner could not provide details about these treatments.
Although excision of the mammary nodule had been recommended, the owner preferred to wait, returning 4 years later when the nodule had become an evident mass involving the two mammary chains. A mastectomy was performed in two stages, and the neoplasm was identified as cystic mammary adenocarcinoma. No complications were noted during the postoperative period.

At the time of the mastectomy, the dog was 8 years old and still had hypotrichosis; however, the affected area of the dorsolumbar and lateral trunk regions was now larger than the area originally noted 4 years previously. The hypotrichosis was accompanied by areas of alopecia and desquamation [Figures 1A, 1B]. The owner scheduled an appointment to have the dog reexamined and to have laboratory tests performed to diagnose the dog’s dermatological condition. Unfortunately, the dog was presented in the interim with a pyometra. Despite emergency surgery, the dog died 5 days later. The owner allowed us to collect dermal samples for histopathological examination postmortem.

Dermatohistopathological Findings
In the areas affected by hypotrichosis, superficial orthokeratotic hyperkeratosis and follicular keratosis were evident. Some degree of follicular inactivity in addition to a large number of dysplastic hair shafts and follicles associated with melanin aggregates and peribulbar melanophages were also noted. The arrector pilis muscles were normal, as were the sebaceous glands that showed no atrophy or melanization [Figures 2A-2D]. Rare flame follicles were seen. The elastin content was evaluated by acid orcein and Giemsa staining and was considered normal when compared to the skin of normal adult Doberman pinschers.

Discussion
Although it was not possible to apply hormonal measurements to refute endocrinopathies, the clinical characteristics, evolution, and histopathological details are similar to those found by Miller in red Dobermans, justifying this report. Hormonal disorders such as hypothyroidism, hyperadrenocorticism, and sex hormone dermatoses can cause loss of trunk hair. The first two endocrinopathies (i.e., hypothyroidism and hyperadrenocorticism), if not duly treated, cause a more widespread distribution of hypotrichosis than follicular dysplasias, and hair loss is associated with other clinical signs that clearly indicate the presence of a systemic disease. Sex hormone dermatoses in females usually cause alopecia of not only the trunk but also the perineal and inguinal regions. In addition, abnormalities in the reproductive cycle and increased size of the vulva and mammary glands (i.e., hyperestrogenism) may be noted, or the estrous cycle may be absent or irregular, with loss of hair on the caudal region of the thighs and changes in the general quality of the hair.1,4

Other cutaneous disorders that can cause loss of hair on the trunk region are alopecia X and cyclical flank alopecia; both have unknown etiologies. Dogs affected with alopecia X have a fleecy look because of the gradual loss of primary hair and retention of the secondary hair. As well, affected dogs have areas of hypotrichosis evolving to alopecia, which generally extends to the neck, ears, tail, and caudomedial region of the thighs.1,5 The latter disease, cyclical flank alopecia, occurs in dogs residing in regions of the world where the seasons of the year are well defined. This disease generally has the prominent characteristic of seasonal hair loss and hair regrowth, which causes areas of alopecia with well-demarcated borders that usually become hyperpigmented.1,3,6,7 Histologically, cyclical flank alopecia is characterized by the presence of follicles with the appearance of a malformed foot or an octopus, with marked melanosis of the sebaceous glands and plugs of melanin in sebaceous ducts.1,3,6-8

With chronicity, all of the above dermatopathies tend to cause hyperpigmentation of the alopecia areas; such hyperpigmentation was not observed in the Doberman pinscher presented in this case.

Alopecia X and hormonal disorders such as hypothyroidism and hyperadrenocorticism cause changes to the
Figures 2A-2D—Histopathological features: (A) Dysplastic hair follicle and normal sebaceous glands; (B) hair bulb with melanin aggregates and peribulbar melanophages; (C) melanin deposits in the cortex of a hair shaft; (D) melanin aggregates in the hair follicle wall (secondary hair). Hematoxylin and eosin stain; bar=25 µm.
cutaneous histology, including orthokeratotic hyperkeratosis, follicular dilatation, follicular inactivity, and atrophy of the sebaceous glands. However, accumulation of melanin aggregates in the hair shafts and follicles is not typical. In addition, dogs with hyperadrenocorticism frequently have calcinosis cutis; dogs with hypothyroidism have hypertrophy with vacuolation of the arrector pili muscles; and dogs with alopecia X have decreased elastin levels of the skin, although these are not consistent findings. Nonetheless, the details outlined above are those habitually used as criteria for making a distinction between follicular dysplasias and endocrine dermatosis.

In the dog of this report, orthokeratotic hyperkeratosis, follicular dilatation, follicular inactivity, and melanin deposits were present; however, no atrophy of the sebaceous glands, calcinosis cutis, or abnormalities of the arrector pili muscles or elastin were noted.

Bagladi et al carried out a retrospective study with 107 dogs with endocrine disorders and 71 dogs with follicular dysplasias to determine whether melanosis of the sebaceous glands observed in follicular dysplasias could serve as a criterion for histopathological distinction between the two entities. Bagladi et al concluded that melanosis of the sebaceous glands can occur in endocrinopathies (17.8%), and as long as the melanosis is linked to the sebaceous gland atrophy, the diagnosis of an endocrine disorder is probable. Rothstein et al considered that a large number of dysplastic follicles along with the combination of dysplastic hair shafts, dysplastic follicles, and aggregates of melanin in the hair shaft support the diagnosis of follicular dysplasia.

Follicular dysplasias that bear some histopathological similarity to the follicular dysplasia of black and red Doberman pinchers have been described in several breeds and their crosses. Follicular dysplasias in other breeds, however, can be distinguished by their particular histopathological features and/or by clinical aspects such as age at onset, evolution, and distribution of the hypotrichosis.

From a clinical point of view, several notable characteristics of the case presented here correspond to the cases reported by Miller. These are the breed; the nondilated coat color; the onset of hair loss in adulthood; the fact that the slowly progressive evolution of hypotrichosis, although permanent, did not become generalized; and the fact that the skin maintained its normal thickness and did not become hyperpigmented. From a histological viewpoint, the following corresponding findings are noteworthy: the absence of atrophy and melanization of the sebaceous glands and the presence of peribulbar melanophages, dysplastic hair shafts, and melanin aggregates in the hair and follicles. The pigmentary alterations, while similar to the illustrations in Miller’s report, were less obvious in the dog presented here; however, Miller observed that histological pigmentary changes were less evident in red Dobermans compared to black ones.

In 1995, Foil, taking the Freire-Maia classification of human ectodermal dysplasias as a model, created a classification of canine and feline ectodermal dysplasias in which the follicular dysplasia of black and red Doberman pinchers is considered a form of color dilution alopecia within group Ia. Foil admitted that Doberman pinchers are heterozygotes (Dd) and not homozygotes (dd) as are dogs with diluted coats; however, these two dysplasias (i.e., follicular dysplasia of black and red Doberman pinchers and color dilution alopecia) have pigmentary alterations of the hair follicles in common. Thus, the possibility that these two conditions are clinical variants of the same pathological entity should not be refuted. Considering there was no dilution of color in the dogs studied by Miller, nor in the female red Doberman pincher presented in this case (and differences are obvious in the evolution and distribution pattern of the hypotrichosis between the two dermatoses, and the pigmentary alterations are much more evident in the color dilution alopecia), we suggest that these two conditions should be considered different dysplasias. This case may in fact be one of locus heterogeneity (i.e., when different genes determine similar clinical conditions).

Conclusion

Follicular dysplasia of the adult Doberman pincher should be considered in the differential diagnosis for all Doberman pinchers with adult-onset bilateral hypotrichosis on the trunk. Although this follicular dysplasia appears to be uncommon, the lack of reports and detailed studies may reflect the lack of diagnosis rather than its true frequency in dog populations.

References


