Excision of a congenital laryngeal cyst in a five-month-old dog via a lateral extraluminal approach

Laura C. Cuddy, MVSc; Nicholas J. Bacon, MD; Alastair R. Coomer, BVSc, MS, DACVS; Cynthia J. Jeyapaul, BS; Barbara J. Sheppard, DVM, PhD, DACVP; Matthew D. Winter, DVM, DACVR

Case Description—A 5-month-old neutered male Golden Retriever was evaluated because of moderate stridor, exercise intolerance, and dyspnea. The dog had been neutered 3 weeks previously, and the referring veterinarian identified a large fluid-filled swelling on the left lateral aspect of the larynx during anesthetic intubation for that surgery. The referring veterinarian drained fluid from the mass by use of needle centesis via the oral cavity, which resulted in temporary improvement in clinical signs; however, the clinical signs returned soon thereafter.

Clinical Findings—A large, soft, spherical mass was located between the left arytenoid and thyroid cartilages and axial to the left ceratohyoid bone, thus causing partial obstruction of the rima glottidis. Laryngoscopic examination, computed tomography (CT), and cytologic evaluation of aspirates performed before surgery; examination during surgery; and histologic evaluation of tissues following surgical excision confirmed the diagnosis of a laryngeal cyst.

Treatment and Outcome—Complete surgical excision was successfully performed via a lateral extraluminal approach to the larynx. One week after surgery, the dog coughed only occasionally. Twelve months after surgery, the owner reported that the dog was clinically normal with no recurrence of clinical signs, and laryngoscopic examination revealed no recurrence of the cyst or other pathological changes in the laryngeal region.

Clinical Relevance—Congenital laryngeal cysts are rarely reported in domestic animals. The information provided here described the CT appearance of a laryngeal cyst and the use of CT in diagnosis and surgical planning. Congenital laryngeal cysts can be resected via a lateral submucosal approach. (J Am Vet Med Assoc 2010;236:1328–1333)

A 5-month-old male Golden Retriever was examined by a referring veterinarian because of excessive panting, stridor, intermittent dyspnea, and mild exercise intolerance, as well as for routine neutering. During laryngoscopic examination and endotracheal intubation prior to the neuter surgery, a fluid-filled mass was detected on the left lateral aspect of the larynx. Needle centesis of the mass via the oral cavity yielded a colorless, serous fluid; subsequently, the mass was completely drained via this approach. Cytologic examination of the fluid revealed acellular serous fluid. Resolution of clinical signs was noticed immediately following drainage and collapse of the cyst-like structure, and neuter surgery was performed without complications.

Signs of respiratory tract problems returned 3 weeks later, at which time the dog was referred to the University of Florida Veterinary Medical Center for further diagnostic testing. Obvious stridor and panting were detected during physical examination performed at the time of admission. The increase in respiratory tract noise was localized to the larynx. No abnormalities were detected during external palpation of the larynx, and all other results of physical examination were within expected limits.

Additional diagnostic testing was conducted. Anesthesia was induced and maintained at a light surgical plane by use of a continuous rate infusion of propofol (0.2 mg/kg/min [0.09 mg/lb/min], IV), and laryngeal examination was performed. A large mass protruded from the left side of the larynx and partially obstructed the rima glottidis (Figure 1). Laryngeal function was otherwise considered to be normal, with full abduction of both arytenoid cartilages identified. Computed tomography* was performed (120 kV and 75 mAs) from the level of the frontal sinuses caudally to the midbody of the third cervical vertebra. Images were obtained before and after use of contrast enhancement. A nonionic iodinated positive-contrast agent† was injected (800 mg of iodine/kg [364 mg of iodine/lb], IV) for the contrast-enhanced images. Images were reconstructed by use of the department's ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>Computed tomography</td>
</tr>
<tr>
<td>WL</td>
<td>Window level</td>
</tr>
<tr>
<td>WW</td>
<td>Window width</td>
</tr>
</tbody>
</table>

From the Departments of Small Animal Clinical Sciences (Cuddy, Bacon, Coomer, Jeyapaul, Winter) and Infectious Disease and Pathology (Sheppard), College of Veterinary Medicine, University of Florida, Gainesville, FL 32610. Dr. Coomer’s present address is Veterinary Surgical Centers, 1048 University Ave, Berkeley, CA 94710. Address correspondence to Dr. Cuddy (CuddyL@vetmed.ufl.edu).

*Computed tomography
†Positive-contrast agent

1328 Scientific Reports JAVMA, Vol 236, No. 12, June 15, 2010
of bone (WL, 350; WW, 2,700; slice thickness, 2 mm; and a sharp filter) and soft tissue (WL, 68; WW, 192; and slice thickness, 2 mm) algorithms. Sagittal and dorsal plane reformatted images were also created by use of a soft tissue algorithm (WL, 68; WW, 192; and slice thickness, 3 mm) for the data set obtained after injection of the contrast agent.

A hypoattenuating, oval, ring-enhancing, 1.6-cm mediolateral × 2.5-cm dorsoventral × 2.9-cm rostrocaudal cyst-like structure with CT values of 25 to 32 in its central portion was detected between the left arytenoid and thyroid cartilages and axial to the left ceratohyoid bone. The mass obstructed approximately half of the laryngeal lumen (Figure 2). After IV administration of the contrast agent, a small amount of the positive-contrast medium was injected directly into the mass to further define its extent. The structure was subsequently drained and then filled with positive-contrast medium, and the CT examination was repeated (Figure 3). Contrast medium in the lumen remained within the capsular margin. Cytologic examination of fluid aspirated from the cyst revealed acellular, protein-rich material, which was consistent with fluid from a noninflamed cystic structure. An extraluminal submucosal laryngeal cyst associated with the left lateral aspect of the larynx at the level of the ceratohyoid bone was diagnosed.

Treatment options were discussed with the owner, and a left lateral approach to the larynx for exploration and excision of the cyst was planned. The dog was premedicated with hydromorphone (0.09 mg/kg [0.04 mg/lb], IV). Anesthesia was induced with diazepam (0.2 mg/kg, IV) and propofol (3 mg/kg [1.4 mg/lb], IV) and maintained with isoflurane in oxygen. The dog was placed in right lateral recumbency, and a linear incision was made ventral to the bifurcation of the lingual facial and maxillary veins on the left side. The subcutis and platysma muscles were incised, and the fibers of the thyropharyngeus muscle were sharply divided at the cranial end of the thyroid cartilage and parted to expose the dorsal edge of the thyroid cartilage. Metzenbaum scissors were used to incise the thyropharyngeus muscle in a caudal direction to reveal the length of the cartilage. Hemostasis was achieved by use of monopolar electrocautery. The wing of the left thyroid cartilage was retracted laterally by use of a single 2-0 polypropylene mattress stay suture. The cricothyroid attachment was not disrupted. An assistant applied digital pressure to the cyst via the laryngeal glottis, and the cyst was exposed between the left arytenoid cartilage wall laterally and the thyroid cartilage wall medially. The cyst was dissected from the surrounding tissues by a combination of blunt and sharp dissection, and it was then completely excised. The laryngeal mucosa was not incised. A fluid sample from the cyst was submitted for cytologic examination and bacterial culture, and the excised cyst tissue was submitted for histologic examination. The thyropharyngeus muscle was apposed and sutured with 3-0 poliglecaprone 25 in a simple continuous pattern, and then the platysma muscle and subcuta-

Figure 1—Photograph of the oral cavity and laryngeal area of an anesthetized 6-month-old neutered male Golden Retriever with moderate stridor, exercise intolerance, and dyspnea. Notice the large mass (ie, laryngeal cyst) protruding from the left side of the larynx that partially obstructs the rima glottidis.

Figure 2—The CT images obtained by use of 120 kV and 75 mAs after IV administration of positive-contrast agent to the dog of Figure 1. Images are displayed in a soft tissue window (WL, 68; WW, 192) and include an axial reconstructed image (A), a sagittal reconstructed image (B), and a dorsal reformatted image (C). Notice the location and the extent of the cyst (asterisk). The cyst is adjacent to the endotracheal tube (et) and causes the tube to be deviated to the right. Also notice the location of the cyst relative to the left ceratohyoid bone (white arrowhead; panels A and C) and the left thyroid cartilage (arrow; panels B and C). The arytenoid cartilage is not included in the plane of these images. L = Left.
neous tissues were apposed in a single layer by use of a simple continuous pattern of 3-0 poliglecaprone 25. The skin was sutured with 3-0 nylon in a simple interrupted pattern. Methylprednisolone sodium succinate (4.3 mg/kg [1.95 mg/lb], IV) was administered during a 10-minute period to reduce laryngeal edema. Laryngoscopic examination performed after surgery revealed normal laryngeal function with marked left-sided submucosal edema and bruising of the left arytenoid and epiglottic areas.

Cefazolin (22 mg/kg [10 mg/lb], IV, q 6 h), hydromorphone (0.2 mg/kg, IV, q 6 h), famotidine (0.5 mg/kg [0.23 mg/lb], IV, q 12 h), and acepromazine maleate (0.01 mg/kg [0.0045 mg/lb], IV, q 4 h) were administered after surgery. The dog was placed in an oxygen cage (oxygen concentration, 40%). The day after surgery, hydromorphone was discontinued, and buprenorphine (0.02 mg/kg [0.009 mg/lb], IV, q 6 h) was initiated for pain relief. Supplemental oxygen was discontinued at this time. A second dose of methylprednisolone sodium succinate (4 mg/kg [1.8 mg/lb], IV) was administered, and 12 hours later, dexmethasone (0.22 mg/kg [0.1 mg/lb], IV, q 12 h) was initiated because of an increase in inspiratory effort and noise during inspiration.

Cytologic evaluation of fluid aspirated from the cyst at the time of surgery revealed neutrophilic inflammation with bacterial sepsis. Bacterial culture yielded moderate growth of *Pasteurella multocida*, which was susceptible to all antimicrobials tested, and minor growth of a nonhemolytic *Staphylococcus* sp.

Histologic examination revealed a cystic structure composed of an outer fibrous wall with a ciliated pseudostratified epithelial lining (Figure 4). The outer fibrous wall was heavily infiltrated with neutrophils and had evidence of multifocal edema, small hemorrhages, multifocal deposits of fibrin, and large numbers of neutrophils within blood vessels lined by reactive endothelial cells. The pseudostratified ciliated epithelial lining indicated the structure was a cyst. The epithelium was vacuolated with alternating multifocal hyperplastic areas and areas with attenuated and eroded epithelium with moderate neutrophilic exocytosis. There was no evidence of neoplastic cells in any of the examined sections, and examination of sections stained with Gomori methenamine silver stain for detection of fungal organisms yielded negative results. The morphological diagnosis was most consistent with an inflamed cyst with a wall densely infiltrated by a suppurative infiltrate.

Forty-eight hours after the surgery to remove the cyst, the dog was anesthetized with propofol (3.9 mg/kg [1.77 mg/lb], IV). Examination of the laryngeal area was performed, which revealed that the submucosal edema and bruising on the left side had resolved. The dog was discharged to the owner 5 days after surgery. The owner was instructed to administer cephalexin (22 mg/kg, PO, q 8 h), famotidine (0.43 mg/kg [0.2 mg/lb], PO, q 12 h), and tramadol hydrochloride (4.3 mg/kg, PO, q 12 h) to the dog. In addition, a tapering dose of methylprednisolone sodium succinate (0.86 mg/kg [0.39 mg/lb], PO, q 12 h for 5 days, followed by 0.86 mg/kg, PO, q 24 h for 5 days, and finally by 0.86 mg/kg, PO, q 48 h for 10 days) was administered to help reduce laryngeal inflammation. The owners were advised to strictly adhere to exercise restrictions, use of a harness for walking, and feeding instructions (eg, the dog was to be fed meatballs) until the skin sutures were removed.

The dog was doing well clinically 1 week after discharge, with only an occasional cough reported. Twelve months after surgery, the dog appeared to have recovered completely with no recurrence of clinical signs reported by the owners. No abnormalities were detected during laryngoscopic examination performed in the anesthetized (propofol; 4 mg/kg, IV) dog 12 months after surgery.

**Discussion**

Laryngeal cysts are rarely reported in humans and other animals. To our knowledge, there is only 1 other report of a confirmed laryngeal cyst in a dog, and the cyst reported here is the first laryngeal cyst diagnosed with the aid of CT imaging.

The canine larynx develops from the cranial region of the laryngotracheal groove (a ventral groove in the...
floor of the foregut at the level of the fourth pharyngeal arch), which communicates with the primordial pharynx. The epithelium derives from foregut endoderm and the mesoderm of the left and right fourth pharyngeal arches and gives rise to the arytenoid, thyroid, and cricoid cartilages. A number of schemes have been proposed for the classification of laryngeal cysts. In humans, laryngeal cysts were first classified in 1970 on the basis of their pathogenesis into saccular, ductal, or thyroidal foraminal cysts. This human classification of laryngeal cysts was subsequently adapted for veterinary use in 1977. Saccular cysts are appendages of the laryngeal sacculus that form in the laryngeal submucosa and are the largest cysts of the larynx. They form when there is obstruction or atresia of the orifice of the laryngeal sacculus, which results in accumulation of mucus in the laryngeal sacculus. These cysts are considered to be congenital and usually do not result in clinical signs during childhood, but they may increase in size. Ductal cysts or retention cysts form commonly in the vallecula epiglottica (a depression caudal to the base of the tongue, between the median and lateral glossoepiglottic folds on each side) or vocal folds but they can form in a mucous membrane at any site in the larynx where mucosal glands are located. They are generally smaller than saccular cysts and develop secondary to obstruction of the ducts of the submucosal mucous glands. Thyroid cartilage foraminal cysts are considered rare in domestic animals. They appear to be a herniation of the subglottic laryngeal mucosa through a persistent foramen in the thyroid ala.

Other more recent classification schemes for cysts in humans have been described. In 1 report, a modified working classification for laryngeal cysts was proposed that included epithelial (columnar or squamous), tonsillar, or oncocytic cysts on the basis of the histologic identification of the cell lining. In another report, cysts were classified into congenital, retention, or inclusion cysts on the basis of genesis and development. In a third report, congenital saccular laryngeal cysts were classified on the basis of their extent and the embryological tissue of origin, and treatment guidelines were proposed in accordance with this classification system. Most laryngeal cysts are situated in the vocal folds. Some cysts may extend beyond the anatomic borders of the larynx.

To our knowledge, there has been only 1 report of a confirmed laryngeal cyst in a dog. In that report, a ductal laryngeal cyst that extended from the right side of the vallecula epiglottica to the oral side of the epiglottis was detected in a 1-year-old Bassett Hound. Clinical signs in that dog included respiratory distress and swallowing disturbances during a period of 11 months. Examination of fluid aspirated from that laryngeal cyst revealed an acellular transudate, but clinical signs recurred 9 days after the cyst fluid was completely aspirated. The cyst in the Bassett Hound was successfully treated by surgical excision via the oral cavity. Histologic examination revealed a cystic structure in the submucosal connective tissue, which was lined in areas by squamous epithelium with no respiratory epithelium, and an underlying layer of fibrous connective tissue. No recurrence of clinical signs was detected in the Bassett Hound following complete excision.

Laryngeal cysts have been identified in other species in a similar location to that of the cyst reported here. An intramural laryngeal cyst was diagnosed with the aid of ultrasonographic examination in a 4-year-old cat with dyspnea and respiratory noise. Clinical signs recurred following complete evacuation of the cyst via ultrasound-guided aspiration. That cyst was 1.5 X 1 cm and was located between the thyroid lamina laterally and the vocal fold, laryngeal sacculus, and aryepiglottic mucosa medially. Complete surgical excision of the cyst via a ventral laryngofissure approach necessitated the removal of these latter soft tissue structures that abutted the laryngeal lumen. That cyst was lined with stratified squamous epithelium. The cat was clinically normal 18 months after surgery. Other investigators have reported the surgical diagnosis and excision of an intramural laryngeal cyst in a horse. That cyst was located between the medial aspect of the thyroid cartilage and lateral aspect of the arytenoid and cricoid cartilages, and it caused laryngeal hemiplegia that resulted in increased noise during exercise. Histologically, that cyst was lined by pseudostratified ciliated columnar epithelium, and it was classified as a paralaryngeal accessory bronchial cyst. Subepiglottic cysts have been reported in horses and are suspected to arise from embryological remnants of the thyroglossal duct or secondary to trauma or inflammation, but true laryngeal cysts are rare.

Laryngeal cysts in domestic animals and humans are lined most commonly by squamous cell epithelium or by ciliated pseudostratified columnar epithelium within a fibrous stroma. In the dog reported here, the cyst was located in the submucosa and was lined by ciliated pseudostratified columnar respiratory epithelium. Given its anatomic location and epithelial lining, and in accordance with the classification scheme adapted for veterinary use in 1977, this cyst can be classified as a saccular laryngeal cyst, with a presumed congenital origin. In the other report of a laryngeal ductal cyst in a dog, the cyst lining was composed of stratified squamous epithelium, in contrast to the respiratory epithelium that lined the cyst wall in the dog of the present report.

Treatment of laryngeal cysts via aspiration alone appears to be ineffective in humans and domestic animals, with rapid recurrence of clinical signs. Complete surgical excision appears to be curative in all patients; however, the optimal treatment differs between congenital and acquired cysts in humans. Supraglottic and subglottic retention cysts in humans may be cured by a single endoscopic incision or marsupialization, whereas the optimal treatment for congenital or saccular cysts in humans depends on the extent of the cyst as defined in a 2004 report. Type 1 cysts consist solely of endodermal elements and are confined to the larynx. Type 1 cysts can be
completely removed endoscopically. Type II cysts extend beyond the anatomic confines of the larynx and should be removed via an external approach, such as a cranial approach via midline thyroideotomy, to prevent recurrence.  

Surgical approaches described for the treatment of laryngeal cysts in veterinary medicine include an approach via the oral cavity as well as a ventral laryngofissure approach. In the dog described here, it was elected to remove the cyst via a lateral extraluminal approach, rather than via either of these 2 other approaches. Evaluation of the preoperative CT images revealed that the cyst was in the submucosa and located laterally between the left arytenoid and thyroid cartilages and axial to the left ceratohyoid bone. Given its lateral location, it was hypothesized that a lateral approach would be optimum for observation of the region and providing access to the cyst to ensure a timely and complete surgical excision, compared with results for both the oral cavity and ventral laryngofissure techniques. Although the approach via the oral cavity is less invasive than is the lateral approach, the extraluminal nature of the lateral approach theoretically avoids disruption of the laryngeal mucosa, which results in less opportunity for wound contamination, infection, or dehiscence and potentially reduces the risk of severe life-threatening laryngeal swelling that may develop after surgery performed via the oral cavity approach. It is likely that endoscopic removal via the oral cavity may be useful for cysts confined to the larynx (type 1 cysts), as has been reported in humans. Following any procedure performed to remove a laryngeal cyst, the patient should be monitored carefully for respiratory distress. A temporary tracheostomy may be required after surgery in patients with severe laryngeal edema that results in marked respiratory distress and that do not respond adequately to administration of supplemental oxygen. 

Computed tomography was selected as a diagnostic modality for use in rapidly and completely defining the exact anatomic location and size of the cyst and assessing the involvement of adjacent structures to facilitate preoperative planning. Use of CT facilitated the accurate injection of a contrast agent directly into the cyst to determine its extent. Laryngeal examination performed in an anesthetized dog is a useful tool for characterizing the surface location and size of a cyst as well as laryngeal function, but it yields limited information on the complete extent of the cyst in relation to the anatomic confines of the larynx and interaction of the cyst with tissues underlying the surface of the laryngeal mucosa. Evaluation of plain radiographs has a limited role in diagnosis and preoperative planning because of superimposition of adjacent structures in the area, although contrast radiography may be of benefit. Diagnosis of a laryngeal cyst via ultrasonography has been reported in a cat, but the restricted field of view and inability of ultrasonography to penetrate mineralized structures provide an incomplete evaluation of the involvement of adjacent structures. Magnetic resonance imaging may be a potentially useful alternative diagnostic modality. 

The inflammatory process involving the cyst wall was presumed to be subsequent to the iatrogenic introduction of and colonization by commensal bacteria (including the P multocida strain cultured from the cyst sample obtained at the time of surgery) found in the oral cavity. It is likely the bacteria were transmitted during the multiple fine-needle aspirations performed prior to surgical excision of the cyst. 

Congenital laryngeal cysts are an uncommon finding in dogs; however, they should be included in the list of differential diagnoses for juvenile dogs with swallowing disturbances and respiratory distress. Differential diagnoses for a laryngeal mass in a juvenile dog should include a developmental laryngeal cyst, granulomatous laryngitis, chronic sialocele, neoplasia, and abscesses. Diagnosis may be achieved via evaluation of the medical history and results of direct laryngoscopy, radiography, ultrasonography, CT, magnetic resonance imaging, cytologic examination of aspirates, and histologic examination of excised cyst tissue. The use of CT for the diagnosis of laryngeal cysts in humans has been reported, but to our knowledge, the information provided here is the first description of the use of CT for the diagnosis of a laryngeal cyst in a domestic animal. 

To our knowledge, there is only 1 other report of successful treatment of a laryngeal cyst in a dog. The cyst in the dog reported here was located between the arytenoid and thyroid cartilages and axial to the left ceratohyoid bone, as determined by use of CT. The cyst was successfully removed via a lateral extraluminal approach to the larynx, as indicated by long-term resolution of clinical signs. A congenital laryngeal cyst should be considered as a differential diagnosis for a juvenile dog with stridor, exercise intolerance, and difficulty swallowing.

References
From this month's AJVR

Tear volume, turnover rate, and flow rate in ophthalmologically normal horses

Thomas Chen and Daniel A. Ward

Objective—To determine tear volume, turnover rate, and flow rate in ophthalmologically normal horses by use of fluorophotometry.

Animals—12 mares free of ophthalmic disease.

Procedures—2 µL of 10% sodium fluorescein was instilled onto 1 eye of each horse, and tear samples were collected via microcapillary tubes from the inferonasal conjunctival cul-de-sac at 0, 2, 4, 6, 10, 15, and 20 minutes after instillation. Collected tear samples were then measured for fluorescein concentrations with a computerized scanning ocular fluorophotometer. A decay curve plot of concentration changes over time was used to determine tear flow rate and volume through 2 different mathematical treatments of the data (the including method and the excluding method).

Results—Fluorescein concentration in tears decreased in a first-order manner. The including method yielded a mean tear volume of 360.09 µL, a turnover rate of 12.22%/min, and a flow rate of 47.77 µL/min. The excluding method yielded values of 233.74 µL, 13.21%/min, and 33.62 µL/min, respectively. Mean ± SD correlation coefficients for the natural logarithm of the fluorescein concentration versus time were 0.93 ± 0.12 for the including method and 0.98 ± 0.03 for the excluding method.

Conclusions and Clinical Relevance—The excluding method yielded more accurate results. A tear flow rate of 33.62 µL/min and a tear volume of 233.74 µL imply a complete recycling of the tear volume in approximately 7 minutes and suggest that increased dosing regimens or constant infusion methods for topical administration of ophthalmic drugs may be indicated when treating horses for corneal disease in which high ocular surface concentrations are needed. (Am J Vet Res 2010;71:671–676)