A 1.5-year-old spayed female Bernese Mountain Dog was examined at the University of California-Davis William R. Pritchard Veterinary Medical Teaching Hospital for a 6-month history of intermittent wheezing, coughing, vomiting, and regurgitation. Prior to this visit, the dog had been evaluated by the referring veterinarian for wheezing after an episode of vomiting. Thoracic radiography revealed a mild interstitial pattern, and the dog was treated with a course of doxycycline (5.5 mg/kg [2.5 mg/lb], PO, q 12 h for 21 days) for suspected aspiration pneumonitis and famotidine (0.25 mg/kg [0.11 mg/lb], PO, q 12 h) and sucralfate (1 g, PO, q 8 h) for a presumptive diagnosis of gastroesophageal reflux disease. Slow but gradual improvement was noted; however, clinical signs subsequently recurred and were no longer responsive to treatment, prompting referral.

As part of the history, the owner reported excessive eructation, lip-smacking, and repeated episodes of hard swallowing. Physical examination results were unremarkable other than a body condition score of 7/9 (50.8 kg [112 lb]). Results of a CBC and serum biochemical analysis from the referring veterinarian were within reference ranges. Thoracic radiography revealed no abnormalities, and videofluoroscopy after administration of barium revealed intermittent gastroesophageal reflux during the liquid phase, with passage of the liquid bolus halfway up the thoracic esophagus.

The dog was anesthetized for endoscopic examination of the upper respiratory and gastrointestinal tracts. Laryngoscopy revealed a hyperemic and mildly swollen larynx with subjectively normal function. Esophagoscopy showed multifocal pinpoint hyperemic mucosal lesions in the distal esophagus consistent with chronic irritation secondary to reflux. The dog was discharged, and the owner was instructed to administer sucralfate slurry (1 g, PO, q 8 h) and omeprazole (0.8 mg/kg [0.36 mg/lb], PO, q 12 h), feed a low-fat diet, and administer metoclopramide (3.4 mg/kg [1.5 mg/lb], PO, q 12 h) to improve gastric emptying.

Over the course of 4 to 6 months, eructation and lip smacking gradually resolved; however, the dog developed progressive episodes of respiratory distress characterized by loud wheezing, open-mouth breathing, gasping for air, and cyanosis, and it returned for...
reevaluation. On physical examination, the dog was bright, alert, and responsive, with a body condition score of 7/9 (51 kg [112.2 lb]). Heart rate was 120 beats/min, and the dog was panting but eupneic and had normal lung sounds on thoracic auscultation. One 30-second episode of marked inspiratory and expiratory stridor was observed, which was accompanied by cyanotic mucous membranes.

Cervical and thoracic radiography revealed a broad-based irregularly marginated soft tissue opacity within the trachea at the level of the fourth rib (Figure 1). Differential diagnoses included granulomatous, neoplastic, and parasitic disease. Results of a CBC, serum biochemical analysis, and urinalysis were within reference ranges, and a heartworm test was negative. Abdominal ultrasonography was performed to screen for neoplastic and other diseases, and results were unremarkable. Tracheoscopy was scheduled.

The patient was premedicated with acepromazine (0.015 mg/kg [0.007 mg/lb], IM) and hydromorphone (0.06 mg/kg [0.027 mg/lb], IM). Once sedated, an IV catheter was placed in the cephalic vein, the dog was preoxygenated via a face mask, and anesthesia was induced with a combination of propofol (0.4 mg/kg [0.18 mg/lb]) and midazolam (0.13 mg/kg [0.06 mg/lb]) administered IV; laryngeal examination again revealed apparently normal function. The dog was then intubated with a shortened 14-mm endotracheal tube, and anesthesia was maintained with oxygen and sevoflurane. Tracheoscopy was performed (LRJ) with a 4.9-mm-outer-diameter, 4-way flexion videoendoscope. At approximately 40 cm from the oral cavity, a firm, irregular mass lesion was seen appearing to originate from the ventral floor of the trachea (Figure 2). The mass occluded approximately one-half of the tracheal lumen, spanned approximately 4 to 5 tracheal rings, and terminated approximately 2 cm cranial to the carina. Endoscopic fine-needle aspiration was attempted; however, a sample of low cellularity was obtained because of the firmness of the mass. Nonetheless, cytologic interpretation was suggestive of neoplasia, with moderately pleomorphic spindle cells and a second population of cells present in rafts, suggestive of an epithelial origin.

Debulking of the mass was attempted; however, endoscopic instruments were damaged in efforts to grasp the firm mass. Small biopsy samples were obtained and submitted for histopathologic examination. A wire snare was then placed around the mass in an attempt to resect the lesion, but the firmness of attachment to the tracheal wall precluded resec-
A CT scan with contrast was then performed to define borders of the mass for possible surgical resection of the lesion. Computed tomography revealed a partially mineralized, 3.8-cm diameter broad-based mass within the ventral tracheal lumen that terminated 1.3 cm cranial to the carina (Figure 3).

Anesthesia was discontinued, and recovery was uncomplicated. The dog was discharged home on the evening of the procedure. No medications were prescribed at discharge.

Results of histopathologic examination of biopsy samples stained with H&E revealed pink extracellular matrix and pleomorphic spindle cells typical of osteoid or chondroid origin, as well as rafts of cells with distinct cell borders, basophilic cytoplasm, and round to ovoid nuclei, characteristic of epithelial cells. No histologic evidence of malignancy was reported. Because of the close proximity of the mass to the carina, surgical resection and tracheal anastomosis were considered high risk because of the likelihood of excessive tension at the surgical site leading to dehiscence. Given the probable benign but obstructive nature of the mass, the dog was scheduled for minimally invasive endoscopic resection.

Preparations were made to use electrocautery and a surgical diode laser endoscopically. The dog was premedicated with morphine (0.5 mg/kg [0.23 mg/lb], IM) and tiletamine-zolazepam (5 mg/kg [2.3 mg/lb], IM). Because of the risk of combustion within the airway with use of high concentrations of oxygen, an air-oxygen mixture (inspired oxygen fraction of 21% to 30%) was administered throughout. Anesthesia was induced with propofol (3 mg/kg [1.4 mg/lb], IV) and midazolam (0.25 mg/kg, IV), and the dog was intubated with a shortened 14-mm endotracheal tube. Anesthesia was maintained (PJP) by means of administration of a CRI.
of propofol (0.2 mg/kg/min [0.09 mg/lb], IV) with fentanyl boluses given IV in 50-µg increments.

Tracheoscopy was performed (LRJ) with a laser-capable fiberoptic endoscope, and the mass was visualized (Online supplement available at http://avmajournals.avma.org/toc/javma/247/11). The mass was readily snared with a wire snare, and electrocautery was applied starting at 15 W and increased to 88 W over the course of 1 hour; however, there was minimal disruption of the attachment of the mass to the tracheal wall. Therefore a 400-µm diode laser fiber was passed through the biopsy channel of the endoscope, and current was applied to the base of the mass with sweeping motions to disrupt the point of attachment to the tracheal wall. Smoke that developed in the trachea was evacuated via suction and by temporarily pausing the use of the laser or electrocautery. After approximately 1 hour of laser dissection, the mass began to separate from the tracheal wall. A 3-prong endoscopic retrieval forceps was used to grasp the mass and remove it from the trachea.

A small rim of char and mass (approx 10%) remained in the trachea (Figure 4). The excised portion of the mass was placed in formalin and submitted for histopathologic examination. The approximate duration of the procedure was 2.5 h. After completion of the procedure, the site was inspected for evidence of hemorrhage or iatrogenic rupture of the trachea; no problems were detected, and anesthesia was discontinued. Dexamethasone sodium phosphate (0.1 mg/kg [0.045 mg/lb] IV) was administered at extubation to reduce airway inflammation, and anesthetic recovery was uneventful. The morning after the procedure, the dog was discharged and the owner was instructed to give amoxicillin-clavulanate (15 mg/kg [6.8 mg/lb], PO, q 12 h for 7 days) and prednisone (0.4 mg/kg/d [0.18 mg/lb/d] for 5 days; then 0.2 mg/kg/d [0.09 mg/lb/d], PO, for 5 days; and then tapered to every other day) and humidification of the airway was recommended. Cough suppression was avoided to encourage removal of debris from the airway.

After 1 week, the dog was reevaluated because of complaints of wheezing and respiratory distress. Thoracic radiography and videofluoroscopy revealed a flap-like remnant of the mass in the trachea (Figure 5). Hydrocodone (0.1 to 0.2 mg/kg [0.045 to 0.09 mg/lb], PO, q 6 to 12 h as needed) and acepromazine (0.4 to 0.8 mg/kg [0.18 to 0.36 mg/lb], q 8 to 12 h as needed) were prescribed to lessen respiratory distress, and clinical signs resolved within 1 week.

Histopathologic examination of the mass confirmed a diagnosis of osteochondroma, with findings consisting of a dome-shaped mass of interlinked lamellarized trabecular bone discontinuously capped with hyaline cartilage and a superficial luminal layer of degenerate respiratory epithelium (Figure 6). Spicules of trabecular bone were bordered by palisading osteoblasts or flattened bone lining cells. The intertrabecular space was variably filled with hematopoietic cells and adipose to fibrovascular connective tissue.
The dog was gradually weaned off medications (omeprazole and sucralfate) originally prescribed for suspected gastroesophageal reflux disease. Recheck tracheoscopy 2 months after removal of the mass revealed slight petechiae of the tracheal mucosa but otherwise apparently normal tissue and no indication of mass regrowth (Figure 7). Thirty-two months after treatment, no respiratory or gastrointestinal signs had recurred.

Discussion

Intratracheal obstructive lesions can be neoplastic (benign or malignant), parasitic granulomas, or foreign material. Osteochondromas are the most common tracheal mass lesion in young, large-breed dogs and are considered benign. They are typically firm, well-circumscribed sessile to pedunculated masses with an apical cap-like layer of articular (hyaline) cartilage covering trabecular bone. Although these lesions have been previously defined as neoplasms, histologically, they are most consistent with a dysplastic pathogenesis. Dogs with tracheal osteochondroma can also have osteochondromas elsewhere in the body, a condition that is termed osteochondromatosis. In dogs, horses, and humans, development of osteochondromatosis appears to be associated with the inheritance of a single autosomal dominant gene. In dogs, osteochondromas are usually benign; however, there is documentation of rare transformation into chondrosarcomas or osteosarcomas. With benign osteochondromas, the prognosis is generally good with complete resection, which typically requires tracheal resection and anastomosis. In case reports documenting solitary tracheal osteochondromas in dogs, recurrence was not found after complete excision.

The unique anatomic location of the tracheal osteochondroma in the patient described in the present report made surgical excision difficult. Because the mass was located close to the tracheal carina, a thoracotomy would have been required, with double-lung ventilation necessary throughout surgery. In addition, surgical resection and anastomosis could have resulted in excessive tension on the tracheal site, increasing the risk of dehiscence as a postoperative complication. Other risks associated with surgical excision of an invasive tracheal mass include ventilation complications, secondary infections, and delayed or altered healing of the surgical site resulting in tracheal stenosis. When possible, less invasive procedures would be preferred.

To our knowledge, this is the first report on the use of electrocautery and laser resection for removal of an intraluminal tracheal mass in a dog. In human patients, endobronchial laser ablation has been successfully used for tracheal mass removal. In addition, laser correction of tracheal stenosis has been reported in both human patients and a horse.

Use of surgical laser and electrocautery in the airway during an anesthetic procedure increases the risk for airway fire, as anesthetic maintenance in veterinary medicine is typically achieved with administration of high concentrations of oxygen. To minimize risk of fire in this dog, a low concentration of oxygen (air-oxygen mixture; inspired oxygen fraction of 21% to 30%) was used in combination with an IV CRI of propofol and repeated fentanyl boluses throughout the procedure. Use of nitrous oxide was contraindicated given its tendency to increase the risk of airway fire. In human patients, cases documenting the use of laser therapy in the airway describe use of an alternative anesthetic maintenance protocol, usually in the form of a CRI. In the equine patient, sedation and local anesthetics were utilized for endoscopic laser correction of postoperative tracheal stenosis. The use of heliox, an oxygen and helium mixture, would be another viable option in place of a highly oxygen-enriched mixture. In the case described here, an air-oxygen mixture with maximal fraction of inspired oxygen of 30% was administered through the endotracheal tube and successfully maintained oxygenation while avoiding an airway fire.

This case represented both a diagnostic and therapeutic challenge. History, clinical signs, diagnostic testing, and response to treatment were consistent with a diagnosis of gastroesophageal reflux disease. Recurrence of clinical signs despite treatment together with the development of more severe respiratory complaints of stridor and cyanosis prompted repeated examination and imaging, which revealed the tracheal mass lesion. This highlights the importance of repeated diagnostic evaluations when owners report recurrent or worsening clinical signs. The successful outcome for this dog also highlights the value of the coordinated team approach to both workup and treatment.

In this report, electrocautery and surgical diode laser were used tracheoscopically for successful resection of a large tracheal mass lesion. Although benign, the mass caused clinically important signs via partial obstruction of ventilation. Successful use of laser resection to remove this tracheal mass reinforces the importance of refining noninvasive mass removal techniques and continuing to investigate and expand the application...
of minimally invasive procedures in veterinary medicine. Further experience with laser and electrocautery in endoscopic procedures, increase in the availability of trained personnel, and optimal patient selection will help to ensure positive outcomes in such cases.

a. GIF-XP180N, Olympus, Melville, NY.
b. Hobbs Medical Inc, Stafford Springs, Conn.
c. Telazol, Zoetis Inc, Florham Park, NJ.
d. EG450PES, Fujinon Inc, Wayne, NJ.
e. Birtcher 4400 Power Plus, Electronic Service for Medical Offices Inc, Sunrise, Fla.

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