Use of a unique method for removal of a foreign body from the trachea of a cat

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Case Description—A 2.96-kg (6.5-lb) 9-month-old spayed female domestic longhair cat was admitted for removal of a tracheal foreign body.

Clinical Findings—The cat had moderate respiratory distress but otherwise appeared to be healthy. Thoracic radiography revealed a foreign body in the trachea.

Treatment and Outcome—The cat was anesthetized and endoscopy of the trachea was performed in an attempt to retrieve the foreign body. Endoscopic removal was unsuccessful because of the shape and smooth texture of the foreign body. Surgical removal of the foreign body was not considered ideal because of its location and the risks associated with tracheotomy. Fluoroscopic-guided placement of an over-the-wire balloon catheter caudal to the foreign body was followed by inflation of the balloon and gradual traction in an orad direction, which resulted in successful removal of the foreign body (identified as a piece of landscaping gravel). The cat required supplemental oxygen and supportive care following removal of the foreign body.

Clinical Relevance—A fluoroscopic technique was used as a minimally invasive alternative to endoscopy or open-chest surgery for removal of a foreign body from the trachea of a cat. Use of this technique allowed uninterrupted ventilation of the cat throughout the procedure. (J Am Vet Med Assoc 2010;237:689–694)
smooth portion of the foreign body, and suction was applied. Unfortunately, we were not able to establish sufficient suction by use of this technique to remove the foreign body. In addition, we did not have suction tubing small enough to pass alongside the endoscope to increase the contact area with the foreign body.

Surgeons were consulted to discuss surgical options for retrieval of the foreign body. Pushing the object farther into the bronchial tree with subsequent lung lobectomy was not attempted because the object was too large to completely enter either mainstem bronchus. Given the location of the foreign body and concerns about tracheal healing, it was recommended that surgery be attempted only if all other retrieval techniques failed.

Fluoroscopic-guided removal by use of forceps, as has been reported elsewhere, was considered. However, the foreign body was too large to allow us to maneuver the forceps around the edges of the foreign body, too firm to enable us to indent and grasp the accessible surface, and too smooth to allow us to seize it with the forceps.

Members of the interventional medicine service were consulted. It was decided to perform a fluoroscopic procedure in an attempt to remove the foreign body and avoid the need for a surgical procedure. The cat was positioned in ventral recumbency to allow adequate fluoroscopic visibility of the right and left bronchi during the procedure as well as to maximize ease of ventilation and minimize atelectasis. Location of the foreign body at the carina and origin of the right mainstem bronchus was verified fluoroscopically prior to the procedure (Figure 2).

A bronchoscopy adaptor was connected to the endotracheal tube to allow uninterrupted ventilation throughout the procedure. A 0.025-inch-diameter, 180-cm-long, angled hydrophilic guidewire was passed through the endotracheal tube into the right mainstem bronchus and caudal to the foreign body. A 3F, 60-cm balloon wedge pressure catheter was advanced over the hydrophilic guidewire and positioned with the balloon caudal to the foreign object. The guidewire was then removed and the balloon inflated to a diameter of approximately 5 mm. Gentle traction was placed on the catheter, and the foreign object was easily moved and advanced orad to the larynx. The foreign body was then visible at the arytenoid cartilages, where it was retrieved by use of alligator forceps. The foreign body was a tetrahedral piece of landscaping gravel with edges measuring approximately 5 X 6.5 X 7.5 mm. Use of the described technique allowed the cat to be continuously ventilated while the guidewire and catheter were directed to the appropriate position because the diameter of the catheter was only 1.7 mm and it minimally compromised the tracheal lumen (diameter of 6 to 7 mm). The tracheal lumen was compromised when the balloon was inflated and the foreign body advanced orad because the balloon diameter (approx 5 to 6 mm) was comparable to the diameter of the tracheal lumen. This is in contrast to the technique described in another report in which the broncoscope compromised the tracheal lumen throughout imaging, positioning, and traction of a balloon catheter.

After removal of the foreign body, the cat was moved to the intensive care unit for recovery. During recovery, the cat was unable to maintain oxygen saturation at $\geq 80\%$ when breathing room air. Two aerosolized doses of albuterol were administered through the endotracheal tube to reduce any bronchoconstrictive component secondary to direct physical stimulation of the mucosa by the foreign body, guidewire, or balloon catheter. The cat recovered from anesthesia and was extubated and placed in an oxygen cage in the intensive care unit. One additional dose of dexamethasone so-
dium phosphate (0.1 mg/kg, IV) was administered to control suspected progression of laryngeal edema when the cat had persistent respiratory distress after appropriate sedation and oxygen supplementation.

Restraint for attempted collection of an arterial blood sample resulted in worsening of the respiratory distress, so a venous blood sample was obtained for blood gas analysis. Although venous blood gas analysis is not ideal for evaluating respiratory status, it is suitable for analyzing the acid-base status of a patient. Venous blood gas analysis revealed alkalemia characterized by respiratory alkalosis (pH, 7.45 [reference range, 7.32 to 7.44]; P<sub>co</sub>2, 29.9 mm Hg [reference range, 38 to 46 mm Hg]; P<sub>o</sub>2, 33.6 mm Hg [reference range, 35 to 40 mm Hg]; and HCO<sub>3</sub>–, 21.1 mmol/L [reference range, 24 to 34 mmol/L]).

Following recovery from anesthesia, the cat had several episodes of stress-induced respiratory distress consisting of tachypnea with open-mouth breathing. Thoracic radiography was repeated to evaluate the cause of the persistent respiratory distress. Examination of the radiographs revealed an alveolar pattern in the right and left cranial lung lobes with a mild cardiac shift to the left (Figure 3). Air opacity was evident in the cranial portion of the esophagus in all views. The findings were interpreted as consistent with consolidation of the cranial lung lobes with consideration for secondary aspiration pneumonia, atelectasis secondary to bronchial occlusion, noncardiogenic pulmonary edema, or hemorrhage.

Postoperative care for the cat included oxygen supplementation (oxygen cage) and administration of butorphanol (0.2 mg/kg) and acepromazine (0.02 mg/kg) every 4 to 6 hours as needed for sedation. The β<sub>2</sub>-adrenergic receptor agonist terbutaline sulfate (0.01 mg/kg [0.0045 mg/lb]) was administered SC every 4 hours to reduce any bronchoconstrictive component to the respiratory distress and to increase fluid clearance from the alveoli of the consolidated lung lobes. A constant rate infusion of butorphanol (0.05 mg/kg/h) was initiated to alleviate pain associated with the laryngeal edema. A transtracheal wash or bronchioalveolar lavage was considered, but they were not performed because of cost and anesthetic risk. Sulbactam-potentiated ampicillin (30 mg/kg [13.6 mg/lb], IV, q 8 h) was administered to the cat as a broad-spectrum antimicrobial to treat possible pneumonia.

The cat remained dependent on supplemental oxygen for the first 36 hours after removal of the foreign body. The second day after removal of the tracheal foreign body, the cat was weaned from supplemental oxygen. Repeat thoracic radiography revealed increased bronchial size in both cranial lung lobes with persistent consolidation. Although no longer dependent on supplemental oxygen, the cat continued to have episodes of coughing and mild respiratory distress that were incited by stress or exercise. Two days after admission, the cat was discharged to the owner. The owner was instructed to administer the cat amoxicillin–clavulanic acid (21.1 mg/kg [9.6 mg/lb], PO, q 12 h) and to return the cat to the referring veterinarian weekly for examinations and thoracic auscultation until complete resolution of clinical signs.

At a follow-up examination performed by the referring veterinarian 2 weeks after removal of the foreign body, findings for physical examination, thoracic
auscultation, and thoracic radiography were within anticipated limits. The owners reported that the cat had a return to customary behaviors with increased tolerance for stress and exercise, up to an amount they believed was appropriate for a 10-month-old kitten. During the subsequent months, the cat continued to grow with no apparent adverse effects from the tracheal foreign body. In a follow-up telephone call 3 months after removal of the foreign body, the owners reported that the cat was growing well and playing and behaving normally.

**Discussion**

Tracheal foreign bodies are a rare but potentially life-threatening emergency in cats.\(^3,7,8\) The ability to quickly evaluate, diagnose, and treat respiratory distress is crucial for a favorable outcome. Although surgical removal may be the best option in some patients,\(^7\) minimally invasive techniques decrease recovery time, are presumed to reduce complications, and may be financially advantageous for owners.\(^6,11\) Initial stabilization of a patient is imperative for a successful outcome. Recommendations for initial treatment in humans include oxygen administration, IV administration of fluids if dehydrated, withholding of food prior to anesthesia (if possible), continuous monitoring, and encouraging the patient to remain calm.\(^9,14,15\) For veterinary patients, especially cats, sedation and pain management are particularly essential to minimize anxiety and reduce progressive respiratory distress.

Once a patient is stabilized, radiography is indicated. Thoracic radiography allows for preprocedural evaluation of pulmonary status and the characterization and localization of any radiopaque foreign objects. The success rate for identifying tracheal and bronchial foreign bodies during examination of thoracic radiographs in humans ranges from 53% to 92%.\(^10,16\) Despite this variability, preprocedural thoracic radiography can be used to determine existing pulmonary changes and prepare clinicians and owners for potential complications after foreign body removal.

In the cat described here, the foreign body did not move appreciably despite numerous attempts at endoscopic removal. Suspending the cat by its hind limbs and gently shaking it, as has been described in another report,\(^8\) was unlikely to succeed in changing the location of the foreign body. After failure of removal by use of previously reported techniques, and with surgical removal not desirable because of the foreign body's location, an innovative method was required to successfully remove the foreign body as quickly as possible. One unique method for addressing this challenge was the use of interventional radiology.

Interventional radiology is defined as the use of contemporary imaging techniques, often fluoroscopy, to direct catheters, guidewires, or stents for therapeutic purposes.\(^11\) In 1 case report,\(^17\) an unsuccessful attempt to use fluoroscopy to guide a wire snare to retrieve a tracheal foreign body in a cat was described. Use of interventional radiology for retrieval of a tracheobronchial foreign body in which the anesthetic circuit is maintained was proposed for dogs in a review article\(^11\) but to our knowledge has not been previously described for clinical use in feline patients.

Options for removal of a foreign body from cats have been described in the literature and include invasive surgical procedures or minimally invasive techniques such as tracheoscopy or the use of fluoroscopically guided forceps.\(^3,7,8,17\) All techniques require that the cat be anesthetized and provided with reliable control of the airways. The technical difficulty and potential morbidity associated with thoracotomy for retrieval...
of a tracheal foreign body\textsuperscript{7} argues for consideration of minimally invasive techniques as an alternative to surgical approaches. Currently, use of a rigid bronchoscope is the standard of care for removal of a tracheobronchial foreign body in human medicine.\textsuperscript{12} With the increasing availability of tracheoscopy in veterinary medicine, this removal technique is quickly becoming the standard of care for animals.\textsuperscript{3,5,10,18} However, the small airways of cats make it difficult to perform endoscopy of the respiratory tract because the endoscope frequently occludes the airway lumen, which necessitates repeated extubation and reintubation during a prolonged procedure.\textsuperscript{3} Therefore, techniques with fluoroscopically guided forceps\textsuperscript{9} or the interventional technique described here may prove beneficial because these techniques involve the use of instruments that are of small diameter, which helps to minimize airway occlusion. In the prior report of the use of fluoroscopically guided forceps, the cats required repeated extubation and loss of the anesthetic circuit during the procedure. The technique described for the cat of the present report was unique in its maintenance of the anesthetic circuit and prevention of the need for extubation because all instruments could be passed through the endotracheal tube via an adaptor without impeding inhalation anesthesia, oxygen delivery, and positive-pressure ventilation. Additionally, the forceps described in that other study\textsuperscript{3} were a custom-made instrument and to our knowledge are not commercially available. Furthermore, those forceps appeared to be rigid metal, which may be more traumatic to the trachea and mainstem bronchus than is the hydrophilic guidewire and soft balloon described here. A potential limitation of the technique described here is the risk of pushing the foreign body farther down a bronchus while attempting to pass the balloon catheter around the object. Although this is a risk, careful manipulation of the catheter with gentle, rotating movements helped us to ease the catheter past the foreign body and prevented substantial movement of the foreign body farther into the bronchial tree.

The use of a balloon placed behind a tracheal foreign body has been described in a cat.\textsuperscript{3} In that cat, a Foley catheter was directed caudal to the foreign body and the balloon was inflated and pulled in an oral direction. Endoscopic guidance was used to position the Foley catheter behind the foreign body, which required the cat to be extubated during the procedure.\textsuperscript{3} The cat described here was unique in that the balloon catheter was fluoroscopically guided and advanced over a hydrophilic guidewire, which allowed maintenance of the anesthetic circuit and appropriate ventilation throughout retrieval of the foreign body. Use of the described technique allowed us to ensure the foreign body was not accidentally shifted to completely obstruct a mainstem bronchus during the procedure. Passing the guidewire and catheter by use of fluoroscopic guidance provided confirmation that the guidewire and catheter passed adjacent to the foreign body rather than displacing it deeper into the trachea, which thus alleviated 1 possible complication for attempted nonsurgical removal.

The most common complications in humans after endoscopic removal of tracheobronchial foreign bodies are pneumonia, cardiac arrest, laryngeal edema, and pneumothorax.\textsuperscript{10} Pleural effusion, atelectasis, pneumomediastinum, bronchospasm, fever, tracheal laceration, postoperative stridor, and hypoxia are less common complications.\textsuperscript{5,10,14,19} The severity of preoperative clinical and radiographic pulmonary inflammation correlates well with the incidence of postoperative complications, as does unsuccessful or complicated removal of foreign bodies.\textsuperscript{3,12,20} Thus, quickly and smoothly removing tracheal foreign bodies will reduce the risk of complications and improve overall outcome.

The major postprocedural complication in the cat described here was continued respiratory distress. On the basis of an alveolar pattern in both cranial lung lobes, we considered pneumonia (secondary to the foreign body or aspiration), atelectasis and consolidation secondary to mucus or inflammatory obstruction of the secondary bronchi, noncardiogenic pulmonary edema secondary to airway obstruction, and pulmonary hemorrhage to be possible causes for this condition. The potential for pneumonia was addressed by administration of a broad-spectrum antimicrobial; pneumonia was considered likely, given the prolonged duration of the procedure and the contaminated nature of the foreign body. Atelectasis with consolidation also was considered likely, given the length of time and difficulty involved in removing the foreign body. Noncardiogenic pulmonary edema was considered possible secondary to the laryngeal edema, prolonged airway obstruction, and respiratory distress caused by the foreign body. Pulmonary hemorrhage was considered less likely because during bronchoscopy there was no evidence of hemorrhage or to the foreign body. Because the cat improved with supportive care and administration of a broad-spectrum antimicrobial, further diagnostic testing to elucidate the cause of the pulmonary pattern was not pursued.

Although we used fluoroscopy to guide the removal of the foreign body, the procedure may have been possible via digital radiography and successive exposures in a general practice setting in which fluoroscopy or tracheoscopy is not available. The technique described here allowed for maintenance of the anesthetic circuit during direct imaging for retrieval of the foreign body. Therefore, it should be considered as a first-line approach for use in veterinary patients with small airways and a tracheobronchial foreign body or in veterinary patients in which tracheoscopy is unsuccessful or cannot be safely performed.

a. Vedco Inc, St Joseph, Mo.

b. Torbugesic, Fort Dodge Inc, Fort Dodge, Iowa.

c. Ketaset, Fort Dodge Inc, Fort Dodge, Iowa.

d. Diazepam, Hospira Inc, Lake Forest, Ill.

e. SevoFlo, Abbott Laboratories, North Chicago, Ill.

f. Pediatric bronchoscope, Olympus America Inc, Center Valley, Pa.

g. Four-wire retrieval basket, Olympus America Inc, Center Valley, Pa.

h. DexSP, MWI, Meridian, Ind.

i. DAR airway connector, Tyco Healthcare, Mansfield, Mass.

j. HiWire hydrophilic wire guide, Cook Inc, Bloomington, Ind.


l. Albutorol, ProAir HFA, IVAX Pharmaceuticals Ireland, Waterford, Ireland.

m. NovaPlus, Bedford Laboratories, Bedford, Ohio.

n. Unasyn, Roerig, Belmont, Wash.

References


Correction: Association of periodontal disease, oral procedures, and other clinical findings with bacterial endocarditis in dogs

In the article “Association of periodontal disease, oral procedures, and other clinical findings with bacterial endocarditis in dogs” (*JAVMA* 2009;234:100–107), values in Table 2 for number of control dogs with evidence of immunosuppression and number of control dogs with neoplasia were inadvertently switched. There were 11 (14%) control dogs with evidence of immunosuppression, and 10 (13%) control dogs with neoplasia.