Acquired Airway Collapse

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Acquired airway collapse can involve the cervical or intrathoracic trachea or the mainstem bronchi or may affect all of the larger, cartilage-containing airways. Generalized airway collapse is referred to as bronchomalacia in human medicine. In some dogs with tracheal collapse, histopathology reveals hypocellular tracheal cartilage, which might be responsible for a reduction in cartilage strength. It is unknown whether a similar pathogenesis could lead to diffuse cartilage defects that would result in generalized airway collapse. In dogs with large airway collapse, weakening of the cartilage leads to flattening of the cartilage ring structure, and the trachea or bronchi collapse in a dorsoventral direction. Pressure changes within the airway accentuate collapse.

During respiration, increased negative pressure develops in the cervical trachea on inspiration and the extrathoracic airway tends to collapse during this phase. Lengthening of the dorsal tracheal membrane and protrusion into the airway lumen contribute a dynamic component to the collapse and accentuate inflammation of airway epithelium and excessive mucus production.

The intrathoracic trachea and larger airways tend to collapse on expiration when intrathoracic pressure exceeds airway opening pressure. Small airway disease accentuates the pressure drop that develops down the intrathoracic airways and potentiates collapse. Chronic cough and airway inflammation can perpetuate small airway disease and result in more widespread pulmonary dysfunction.

**DIAGNOSTIC CRITERIA**

**Historical Information**

- **Age/gender predisposition.** Often, dogs have initial signs of airway collapse early in life and develop recurrent episodes of clinical signs. Middle-aged dogs are most often presented with complaints related to airway collapse. Generalized airway collapse appears to be more common in older dogs. Male and female dogs are equally affected.
- **Breed predisposition.** Tracheal or airway collapse occurs most commonly in small-breed dogs. Pomeranians, miniature poodles, Chihuahuas, and Yorkshire terriers have increased incidence. Tracheal collapse will occasionally be encountered in young, large-breed dogs.
- **Owner observations.** The most common complaint reported by owners is a honking cough. Often dogs will gag and retch excessively after coughing, which owners interpret as a productive cough, tracheal foreign body, or vomiting disorder. Animals with diffuse airway collapse may present with exercise intolerance, tachypnea, cyanosis, or collapse.
- **Other historical considerations/predispositions.** Some dogs suffer dramatic worsening of clinical signs when exposed to heat or humidity. Pulmonary infection, upper airway dysfunction, obesity, or congestive heart failure may cause decompensation in a previously stable dog with airway collapse.

**Physical Examination Findings**

- Increased tracheal sensitivity is virtually always present and can be severe.
- The trachea is often more compliant on palpation in affected dogs than in unaffected dogs.
- In dogs with severe tracheal collapse, flattened tracheal rings can be palpable near the thoracic inlet.
- Inspiratory dyspnea can be a sign of cervical tracheal collapse; however, it might indicate laryngeal paralysis, a complication reported in up to 30% of dogs with tracheal collapse. Careful auscultation over the larynx should be performed to rule out this disorder.
- Expiratory collapse of large airways may be heard over the thorax.
- Adventitious lung sounds indicate concurrent small airway disease. Expiratory wheezes or crackles may be heard as small airways collapse and then reopen.
- Careful cardiac auscultation is recommended because 30% or more of dogs with airway collapse may exhibit concurrent mitral insufficiency. A prominent second heart sound could be an indicator of pulmonary hypertension.

**Laboratory Findings**

- Laboratory testing is useful to detect concurrent illness and evaluate the dog’s health before administering anesthesia for airway sampling through transoral tracheal wash or
bronchoscopy with bronchoalveolar lavage.

- Polycythemia or nucleated red blood cells can be indicators of chronic hypoxia.
- Conditions that predispose to obesity (e.g., hypothyroidism, diabetes mellitus, hyperadrenocorticism) should be ruled out.
- Blood gas analysis is not commonly performed in dogs with airway collapse. Nevertheless, hypoxemia can result from laryngeal paralysis (due to alveolar hypoventilation) or chronic bronchitis (probably associated with mismatching of ventilation and perfusion).

Other Diagnostic Findings

- Radiography has been reported to detect tracheal collapse in the majority of affected dogs. Although collapse of the cervical trachea and intrathoracic segment may be readily apparent, collapse of the mainstem bronchi and other airways may be less obvious on static radiography.
- Cervical tracheal collapse is detectable on inspiratory radiographs.
- Intrathoracic tracheal or airway collapse can be seen on expiratory radiographs.
- Obesity or a chondrodysplastic breed conformation can make it difficult to detect pathologic pulmonary infiltrates or to assess the degree of cardiomegaly on thoracic radiographs.

Radiographs must be closely evaluated for signs of congestive heart failure (enlarged left atrium, pulmonary venous enlargement), pneumonia (alveolar infiltrates, air bronchograms), bronchiectasis (dilated airways, pneumonic infiltrates), or bronchitis (peribronchial infiltrates).

- Right-sided cardiomegaly may be an indicator of pulmonary hypertension.
- Echocardiography can be used to assess the degree of left atrial enlargement and assists in determining appropriate therapy for concurrent cardiac disease. Doppler echocardiography can detect pulmonary arterial hypertension when tricuspid regurgitation or pulmonic insufficiency is present.
- Endoscopy is the most accurate method to diagnose and classify tracheal and/or airway collapse (see Table One).
- Collection of airway samples is necessary to document the presence of airway infection or inflammation. If bronchoscopy is not available, a transoral tracheal wash can be performed (see Table Two). A small endotracheal tube is recommended to avoid trauma to the airway lining. Samples are collected for cytology and bacterial culture and/or sensitivity testing. Culture for Mycoplasma should be considered in dogs with acute exacerbation of preexisting respiratory disease, although the role of Mycoplasma in respiratory disease has not been defined.

Summary of Diagnostic Criteria

- Bronchoscopy provides a definitive diagnosis of airway collapse, illustrates the extent of disease, provides information for therapy, and aids in determining prognosis. Evaluation of the upper airway during anesthetic induction determines the presence or absence of laryngeal dysfunction or upper airway obstruction. Collection of airway samples is necessary to document the presence of airway inflammation or infection that might be responsible for

### TABLE ONE

#### Grades of Tracheal Collapse

- **Grade I:** Minor protrusion of the dorsal tracheal membrane into the airway lumen. Airway diameter is reduced by <25%.
- **Grade II:** 50% reduction in the diameter of the tracheal lumen. Rings are elongated and mildly flattened.
- **Grade III:** 75% reduction in tracheal luminal diameter. Rings are markedly flattened. The trachealis muscle is lengthened and brushes the tracheal mucosa. Repetitive coughing leads to chronic epithelial injury.
- **Grade IV:** Severe flattening of the tracheal rings. The lumen is reduced to <10% of the expected diameter. A double-lumen trachea may be encountered when the trachealis muscle contacts the ventral surface of the trachea and the rings have bowed dorsally.

### TABLE TWO

#### Technique for Performing a Transoral Tracheal Wash

- Preoxygenation with a facemask
- Sedation for evaluation of upper airway structure and function
- Oral intubation with a small, sterile endotracheal tube
- Passage of a sterile polypropylene catheter or sterile feeding tube to the level of the carina
- Injection of 4–6 ml of nonbacteriostatic saline
- Aspiration of fluid. Repeat injection and aspiration to obtain approximately 1 ml of fluid. Coupage of the chest may assist in retrieval.
- Possible injection of 1 ml of 1% lidocaine through the tracheal catheter prior to extubation to reduce the cough reflex
- Submission of fluid for aerobic culture and antibiotic sensitivity testing, *Mycoplasma* culture, and cytologic examination
worsening of respiratory disease.

- Fluoroscopy (where available) or dynamic radiography (radiographs taken during a cough) can document tracheal or large airway collapse in dogs with unremarkable static radiographs.

- Thoracic radiography can detect tracheal collapse in approximately 60% of cases.

Differential Diagnoses

- Infectious tracheobronchitis. Usually accompanied by a history of recent exposure to a coughing dog.

- Tracheal or laryngeal obstruction, laryngeal paralysis. Radiographs would reveal a filling defect or mass lesion in most cases with obstruction. Respiratory endoscopy might be required for definitive diagnosis of a mass or functional disorder.

- Chronic bronchitis. Because normal thoracic radiographs do not rule out either tracheal collapse or bronchitis, fluoroscopy or bronchoscopy is needed to provide an accurate assessment of airway structure and function.

- Congestive heart failure. Typically, affected dogs have a soft, moist cough; a rapid heart rate; and tall R waves on an electrocardiogram.

- Pneumonia. Dogs with bacterial pneumonia usually exhibit alveolar infiltrates; those with fungal pneumonia usually exhibit nodular interstitial patterns and hilar lymphadenopathy.

- Ciliary dyskinesia is more commonly seen in young dogs with a history of chronic nasal discharge and respiratory infection. Diagnosis requires electron microscopic documentation of ultrastructural defects in respiratory cilia.

- Heartworm disease and neoplasia are also on the differential list for cough and could be present concurrently with tracheal collapse.

**TREATMENT RECOMMENDATIONS**

**Initial Treatment**

(See Table Three for Emergency Therapy)

- **Oxygen.** Supplementation via facemask or in an oxygen cage is indicated if respiratory distress is noted.

- **Sedation/cough suppression.** Clinical signs in animals that experience severe dyspnea and cough related to stress often are reduced following mild sedation and cough suppression. **Acepromazine** (0.025–0.1 mg/kg SC) in combination with **butorphanol** (0.05–0.2 mg/kg SC) can be used for short-term relief of respiratory distress. In the first 24 hours, these drugs may need to be administered two to four times, depending on the dog’s response and level of sedation. Therapy must be individualized, and caution is warranted because this combination of drugs can produce profound sedation and hypotension. For long-term control of refractory cough, judicious use of **narcotic cough suppressants** is recommended. It is essential to control lung inflammation and to treat infection before using cough suppressants. For long-term control of cough, **butorphanol** (0.5–1.0 mg/kg PO q 4–8 hours) or **hydrocodone** (0.22 mg/kg PO q 4–8 hours) can be used. These drugs are given at an interval that suppresses cough without inducing excessive sedation.

- **Bronchodilators.** For dogs with intrathoracic tracheal or mainstem bronchus collapse, chronic bronchitis, or diffuse collapse of smaller airways, bronchodilators may provide some alleviation of cough and/or dyspnea. Beta-agonists produce smooth muscle relaxation by direct stimulation of receptors on airway smooth muscle. Prototype drugs include **albuterol** (50 µg/kg PO bid or tid) and **terbutaline** (0.625–1.25 mg/small dog, 1.25–2.5 mg/medium-sized dog, and 2.5–5.0 mg/large dog, PO bid or tid). Terbutaline is also available as an injectable drug for animals with acute signs of distress; suggested dosage is 0.01 mg/kg SC. **Theodur®** sustained release tablets (20 mg/kg bid) and **Slo-Bid®** gyro-caps (25 mg/kg bid) are **methylxanthine**.
Antiinflammatory agents. In some dogs, a short course of prednisone may be required to alleviate tracheal inflammation. Prednisone or prednisolone is administered at a dosage of 0.5–1.0 mg/kg PO bid for 3 days and then is rapidly tapered to alternate-day therapy. Unless chronic bronchitis is present, corticosteroids should be discontinued within 7–14 days.

Antibiotics. Significant growth of pathogenic bacteria and/or the presence of intracellular bacteria on cytology indicates airway infection. Antibiotic selection should be based on sensitivity results. Pending these results, antibiotics with good activity against enteric organisms and respiratory pathogens should be chosen. Drugs that share these characteristics and that penetrate lung tissue well include doxycycline (3–5 mg/kg PO bid), chloramphenicol (30–50 mg/kg PO tid), and enrofloxacin (2.5–5 mg/kg PO bid*). Pulmonary infection might require 2–6 weeks of treatment.

Adjunctive Treatments

Surgical correction of upper airway obstructive lesions (laryngeal paralysis, everted laryngeal sacculae, or elongated soft palate) may reduce clinical signs in dogs with concurrent cervical tracheal collapse. Surgical implantation of tracheal ring prostheses, available at select referral centers, can be used to treat cervical tracheal collapse. Providing external support of the cervical trachea can reduce, but not abolish, clinical signs when surgery is performed appropriately. Some dogs require permanent tracheostomy for preexisting or induced laryngeal paralysis. Despite these potential complications, owner satisfaction is reportedly high when this technique has been performed by a skilled surgeon.

Use of a bronchial stent for internal support of larger airways has been investigated in dogs. To date, these stents have not been successful because of problems with stent size, infection around the stent, migration of the stent, or dislodgment from the airway. Dogs may cough excessively with the stent in place, and the stent can collapse. With modifications, bronchial stents might be beneficial in supporting intrathoracic airways.

Supportive Treatment

Weight loss is of critical importance in dogs with airway collapse. It reduces stress on the respiratory system, increases thoracic compliance, improves exercise tolerance, and can increase oxygen exchange. Realistic goals for weight loss should be developed through consultation with the owner. Weight loss of 2%–3% per week is recommended and can be achieved by providing a low-fat, high-fiber diet and encouraging regular exercise. Harnesses should be used rather than collars. Avoidance of heat, humidity, and smoke-filled or polluted environments is recommended.

Patient Monitoring/ Home Management

Weight should be monitored at home.

 Owners can assess response to therapy by documenting the incidence of cough, improvements in exercise tolerance, and occurrence of drug-induced side effects.

Owners are advised that affected dogs may be at risk of acute exacerbation at home despite administration of medication. Acute episodes may include dyspnea, persistent cough, cyanotic mucous membranes, syncope, and, in rare cases, death.

Management of an acute exacerbation at home includes placing the dog in a cool, quiet area; if rapid improvement is not apparent within minutes, the veterinarian should be contacted.

Dogs that suffer acute exacerbation of cough should be evaluated for weight gain, pulmonary infection, chronic bronchitis, or other conditions that can trigger the cycle of airway injury in dogs with tracheal collapse.

Treatment Contraindications

Concurrent use of enrofloxacin, cimetidine, erythromycin, mexiletine, beta-blockers, or calcium channel blockers with theophylline can lead to elevated plasma theophylline levels because of interference with methylxanthine metabolism. Clinical signs of toxicity such as gastrointestinal upset, nervousness, or excitability may result.

Tolerance of previously described bronchodilator therapy (beta-agonists or methylxanthines) is affected by individual variation in metabolism, and dosage must be tailored to the patient.

Use of diuretics may result in transient improvement in clinical signs in dogs with airway collapse because of a reduction in airway secretions; however, continued therapy will result in excessive
drying of respiratory secretions, inspissation of mucus with airway plugging, and worsening of respiratory disease.  
Chronic use of atropine or parasympathomimetic drugs will also result in drying of airway secretions and worsened respiratory disease.

**PROGNOSIS**

**Favorable Prognostic Criteria**
- Most dogs with tracheal collapse have intermittent coughing and clinical signs throughout life. Hopefully, characterization of the extent of disease early in life will improve the chance that the dog can maintain good airway function.
- Early recognition and treatment of conditions that can aggravate tracheal collapse are likely to improve the quality of life.
- Dogs that have focal collapse but no generalized airway disease are likely to have a better prognosis.

**Unfavorable Prognostic Criteria**
- Episodes of acute respiratory distress that recur frequently and require emergency intervention (such as one per month or more).
- Obese dogs that do not lose weight are less likely to experience a reduction in clinical signs.
- Dogs with concurrent laryngeal paralysis or upper airway dysfunction, chronic bronchitis, bronchiectasis, or congestive heart failure are more likely to suffer recurrent exacerbation of clinical signs and will be variably symptomatic for airway collapse.
- Dogs exposed to smoke, humidity, and heat stress are likely to suffer recurrent episodes of respiratory distress.

**RECOMMENDED READING**