Tracheal collapse and bronchomalacia

Tracheal collapse is commonly encountered as a cause of cough and airway obstruction in the dog, particularly in toy breed dogs. The etiology of tracheal collapse is unknown, but some affected dogs have been shown to have a reduction in chondrocytes in tracheal cartilage, which reduces the rigidity of the cartilage ring and allows flattening of the tracheal rings with stretching of the dorsal tracheal membrane. Collapse occurs in a dorsoventral direction with prolapse of the elongated dorsal tracheal membrane into the lumen of the airway. Dynamic collapse during respiration leads to mechanical irritation of the opposing mucosa that enhances tracheal edema and inflammation. The mucociliary apparatus is disrupted and there is increased risk for mucus trapping. The cervical trachea collapses during inspiration while the intrathoracic portion of the trachea collapses on expiration. Many dogs with tracheal collapse have collapse of both the cervical and intrathoracic trachea. The principle or lobar bronchi can also be affected (bronchomalacia) and small airway disease (bronchitis) is variably present.

Recognition of tracheal collapse is often relatively straightforward in the clinical situation, although documenting bronchomalacia is more challenging and can require bronchoscopy. In all cases, determining the severity of respiratory compromise, identification of predisposing conditions that could exacerbate coughing, and early intervention with appropriate therapy are essential for optimal patient management.

Most dogs with tracheal collapse or bronchomalacia have a chronic history of waxing and waning respiratory difficulty or cough that has grown progressively worse over time. No sex predilection has been recognized. At our institution, over 2/3 of dogs diagnosed with tracheal collapse are overweight or obese, although a review of surgically managed patients from the U.K. reported only a 9% incidence of obesity. Tracheal collapse is most commonly recognized in small or toy breed dogs, such as the Yorkshire terrier, Pomeranian, Poodle, Maltese, and Chihuahua. However, both small and large breed dogs can be affected by bronchomalacia. Affected dogs range from 1-15 years of age, although many are middle-aged when first presented.

Many dogs with tracheal or bronchial collapse present with paroxysmal, dry, "honking" cough. Owners can mistake the cough for vomiting or will report gagging or retching in association with the cough, particularly after drinking. Tachypnea, exercise intolerance, and respiratory distress tend to occur in stressful situations, such as during physical exertion, with heat stress, or in humid conditions. This may be the result of chronic lower airway disease and/or concurrent laryngeal obstruction (edema, sacculular eversion, or laryngeal paralysis). Cyanosis or syncope occurs in severely affected animals due to complete airway obstruction or pulmonary hypertension.

Dogs with tracheal collapse can appear normal at rest. Auscultation can reveal musical or wheezing sounds over the trachea caused by turbulent airflow through the narrowed lumen. Dramatic stridor over the upper airway is suggestive of concurrent laryngeal paresis or paralysis, which has been reported in 30% of dogs with tracheal collapse, however severe cervical tracheal collapse can also result in stridor. A flattened cervical trachea might be palpable in severe tracheal collapse. Some dogs with lower airway collapse can have a snapping sound ausculted over the thorax as airways close and snap open following expiration. In some dogs, lung sounds can be difficult to assess due to tachypnoea, obesity, or referred upper airway sounds. Crackles associated with mucus plugging or airway closure suggest that chronic bronchitis or airway collapse is present. Careful cardiac auscultation should be performed to detect concurrent mitral valve insufficiency, which is a common finding in small breed dogs.
Although the diagnosis of tracheal collapse can be strongly presumed based on the signalment, history, and physical examination findings, a complete diagnostic work-up should be performed to define concurrent disorders and provide appropriate therapy. Routine hematologic testing can detect predisposing or concurrent diseases. Radiographs are essential both to investigate tracheal collapse and to detect concurrent pulmonary or cardiac disorders. Inspiratory and expiratory lateral views are sometimes helpful in identifying tracheal collapse and a dorsoventral view should also be performed to complete the examination. On full inspiration, radiographs may show collapse of the cervical trachea with dilation of the intrathoracic trachea. Peak expiratory radiographs can show collapse of the mainstem bronchi and/or the intrathoracic trachea, with ballooning of the cervical trachea. Overall, radiographs suffer from a high number of false positives yet also underestimate the degree of collapse, do not always identify the appropriate site of collapse (cervical versus intrathoracic), and are unreliable in documenting intrathoracic airway or lobar bronchial collapse. Fluoroscopy, where available, is beneficial in providing information on the degree of dynamic airway obstruction, and it also allows correlation of airway collapse with cardiac and respiratory cycles.

Concurrent bronchial disease can appear as a generalized increase in interstitial or bronchial markings throughout the lung fields. Pulmonary infiltrates are often difficult to define in obese dogs due to superimposition of fat over the thorax and within the mediastinum. Cautious interpretation of the cardiac silhouette is warranted in obese dogs with tracheal collapse. Fat around the pericardial space and reduced lung volume, as well as breed-related conformation, can lead to the impression of cardiomegaly. Right-sided heart enlargement can be present in dogs with severe tracheal collapse, pulmonary disease, or other factors that predispose to the development of pulmonary hypertension. Dorsoventral radiographs are helpful in documenting the degree of obesity. The centimetres of fat present between the thoracic cage and the skin can be used for client communication on obesity control and for follow-up comparisons.

Bronchoscopy can document tracheal collapse when radiographs or fluoroscopy are inconclusive. Bronchoscopy also allows assessment of laryngeal structure (edema, saccular eversion) and function, grading the location and degree of tracheal ring flattening, visualization of tracheal inflammation or irritation, and documenting the presence of small airway disease. Bronchoalveolar lavage (BAL) should be performed in all dogs in which bronchoscopy is performed to document bacterial or Mycoplasma infection and to detect inflammation by cytologic examination. Appropriate antibiotic and/or anti-inflammatory therapy can be prescribed based on BAL results. However, the risk of bronchoscopy in dogs with tracheal collapse can be significant, especially in obese animals with severe tracheal sensitivity or expiratory effort. Subcutaneous terbutaline (0.01 mg/kg) can sometimes be helpful in improving respirations post anesthesia. Following the procedure, a slow recovery from anesthesia is advisable to minimize stress, and an oxygen-enriched environment should be available. One cc of 1% lidocaine sprayed into the distal trachea at the end of bronchoscopy can help decrease the cough reflex.

In animals that require inpatient management, stress should be kept to a minimum. Oxygen supplementation is often beneficial. Mild cough suppression and sedation with butorphanol (0.05 - 0.1 mg/kg SC q4-6 hours) and/or acepromazine (0.01 - 0.1 mg/kg SC) can be useful. This combination of drugs seems to provide synergistic sedation, and caution should be employed when using the drugs together. To decrease laryngeal tracheal irritation, a single dose of dexamethasone-SP (0.1 – 0.2 mg/kg IV) can be administered.

Outpatient management should be designed to correct risk factors identified in the diagnostic work-up. In many cases, obesity plays a role in worsened cough and respiratory difficulty. Encouragement of weight loss can result in significant reductions in cough and improvement in overall health. If chronic bronchitis is diagnosed, corticosteroids should be employed as detailed below. Airway infection is treated with appropriate antibiotics. Narcotic cough suppressants are often required to control cough and should be administered often enough to control cough without inducing severe sedation. Suggested drugs include hydrocodone (0.22 mg/kg PO QID-BID) and butorphanol (0.55 - 1.1 mg/kg PO PRN). Bronchodilators (sustained release theophylline at 10 mg/kg PO BID) can be useful in animals with bronchomalacia or small airway disease. They may improve respiration and decrease the likelihood of intrathoracic airway collapse.
Ancillary measures include avoidance of collars and decreased exposure to heat and humidity. Upper airway surgery, if needed, can also improve the dog’s presentation. In some dogs with cervical tracheal collapse, placement of extraluminal ring prostheses will result in dramatic reduction in clinical signs, and studies have also shown improved quality of life following implantation of intraluminal stenting devices for intrathoracic tracheal collapse.

**Chronic bronchitis**

Canine chronic bronchitis is described by the presence of a daily cough for greater than 2 months of the year. Inflammatory damage to the airway results in epithelial cell hypertrophy and squamous metaplasia, goblet cell hypertrophy, submucosal gland hyperplasia, and mucosal/submucosal inflammation, edema, and fibrosis. These result in an increase in the amount and viscosity of airway mucus, narrowing of the airway lumen, and chronic irritation within the airway. Clinically, these changes are manifest by chronic cough.

Chronic bronchitis most commonly affects middle-aged to older dogs (> 8 years of age). Classically, small breed dogs such as poodles and terriers have been considered to have a higher incidence of chronic bronchitis, however, clinical studies and experience have shown that large breed dogs are equally affected. Cough, exercise intolerance, and/or wheezing are variably present in individual cases. Wheezing on expiration is considered a classic finding although many dogs have only a diffuse increase in lung sounds. Most dogs exhibit tracheal sensitivity on palpation. With worsening disease, increased respiratory effort with an abdominal push can be noted, with or without cyanosis. Obesity is a common finding.

The diagnosis of chronic bronchitis requires exclusion of other causes of cough. Tracheal collapse, bordetellosis, *Mycoplasma* infection, heartworm disease, and neoplasia should be ruled out, although these disorders can also be found concurrently with bronchitis. A minimum database (CBC, chemistry, urinalysis) evaluates the dog’s general health but does not specifically address the diagnosis of chronic bronchitis. Thoracic radiographs are an important part of the work-up since they aid in the diagnosis of chronic bronchitis and help rule out other causes of cough. Classically, radiographs show a bronchial pattern or increased number and thickness of airway walls, however radiographs can also be relatively unremarkable, despite fairly obvious airway pathology when bronchoscopy is performed.

Airway sampling is used to define the disease process in dogs with cough. A transoral or transtracheal wash can be useful for obtaining bronchial cytology and ruling out infection. This is a straightforward procedure that can be performed using items commonly found in most veterinary practices. Bronchoscopy is a highly useful technique in evaluating dogs with chronic cough. Changes are commonly seen on visual inspection of the airway and include mucosal hyperemia, increased mucus secretions, irregular mucosal borders, and bronchitic nodules protruding into the airway lumen in chronic cases. Cytologic specimens in chronic bronchitis usually show neutrophilic inflammation or occasionally, mildly eosinophilic inflammation. Bacterial and mycoplasmal cultures are warranted in all animals with suspected bronchitis to rule out a significant bacterial infection.

Anti-inflammatory therapy with corticosteroids is used to break the cycle of mucosal inflammation and to reduce excessive production of secretions in dogs with chronic bronchitis. Prednisone or prednisolone can be used; initially at relatively high doses (0.5 - 1.0 mg/kg BID for 5-7 days) and then tapered as rapidly as possible while maintaining control of cough. Some dogs require alternate day therapy for prolonged periods of time. Exacerbations of disease are treated with an increase in prednisone dosage to the dose that effectively controlled clinical signs. Animals that cannot be controlled on glucocorticoids or those that suffer excessively from side effects associated with steroid use can be treated with inhaled steroids by using a facemask and spacing chamber for delivery. Aerodawg® or facemasks employed in human medicine can be used. Fluticasone propionate remains one of the most potent inhaled steroids and is generally recommended initially. One puff (usually of 110 µg/puff) instilled into the chamber twice daily and administered for 6-8 breaths has proven efficacious in alleviating cough.

Some dogs that fail to respond to anti-inflammatory therapy can benefit from the addition of a bronchodilator or an anti-tussive. The most commonly used bronchodilator is extended release theophylline at 10 mg/kg BID. Narcotic cough suppressants are useful if cough persists after...
inflammation has been controlled. In some dogs, saline nebulization can be helpful in aiding evacuation of mucus. Finally, weight loss should be recommended for obese animals since this may result in improvement in gas exchange and reduction in cough.

Owners should be aware that the prognosis for bronchitis is guarded regarding abolition of cough. This is a chronic disease, and the therapeutic goal is to control clinical signs. Worsening of disease can lead to bronchiectasis or cor pulmonale. Visualization of bronchitic nodules or irregular epithelium during bronchoscopy indicates the irreversibility of the process. Cough may never be abolished in these dogs, and owners must understand the need for continuous therapy.