Tracheal Collapse

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ABSTRACT: Tracheal collapse typically occurs in toy- and small-breed dogs. Pomeranians, miniature and toy poodles, Yorkshire terriers, Chihuahuas, and pugs are most commonly affected. Dogs presenting with tracheal collapse often have a chronic history of waxing and waning respiratory difficulty or coughing that has progressively worsened over time. The history, signalment, and physical examination findings are often strongly suggestive of tracheal collapse, but a thorough diagnostic evaluation, including hematologic testing, electrocardiography, diagnostic imaging, and potentially endoscopic evaluation, should also be completed. The mainstay medical therapy includes antitussives, sedatives or tranquilizers, bronchodilators, and occasionally antibiotics if indicated. Surgical therapy, most commonly total ring prosthesis, is recommended in patients with cervical collapse that is unresponsive to aggressive medical management. Endoluminal stenting is available for patients that are refractory to medical management and have extensive intrathoracic collapse or collapse along the entire length of the trachea.

Tracheal collapse (i.e., tracheobronchomalacia) was first described by Baumann[1] in 1941. This condition is a common cause of cough and airway obstruction in dogs but is rare in cats.[2,3] The exact cause of tracheal collapse is unknown, but different congenital and acquired causes have been proposed. Regardless of the underlying cause, weakened tracheal cartilages become dorsoventrally flattened and laxity in the dorsal trachealis muscle leads to partial or even complete airway obstruction. Tracheal collapse is irreversible, but several medical and surgical options can help palliate clinical signs.

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ANATOMY

The trachea connects the upper airway system (i.e., nasopharynx, oropharynx, larynx) with the lower airway system (i.e., bronchi, bronchioles, alveoli) of the lungs.[4] Approximately 35 to 45 C-shaped hyaline cartilage tracheal rings are found in dogs and 40 in cats, but these numbers vary among individuals and breeds.[5,6] The tracheal rings are connected by annular ligaments ventrally and laterally and the trachealis muscle dorsally.[4] The tracheal mucous membrane is lined by a pseudostratified ciliated epithelium and contains mucus-secreting goblet cells and tracheal glands in the submucosa.[4] A segmental blood supply exists, with the cranial and caudal thyroid arteries supplying most of the trachea and the bronchoesophageal arteries delivering blood to the terminal trachea, carina, and pulmonary bronchi.[5,6] The main innervation to the tracheal mucosa and smooth muscle is the right vagus nerve and its recurrent laryngeal branch.[5,6]

SIGNALMENT AND HISTORY

Tracheal collapse typically occurs in toy- and small-breed dogs. Pomeranians, miniature and toy poodles, Yorkshire terriers, Chihuahuas, and pugs are most commonly affected.[4,5,7–9] There is no reported gender predilection. Tracheal collapse has been diagnosed in dogs of all ages (i.e., 1 to 15 years), and although approximately 25% of affected dogs are symptomatic by 6 months of age, the condition typically affects middle-aged dogs 6 to 7½ years of age.[4,5,7–9] In most cases, signs of respiratory compromise have been evident for at least 2 years by the time of presentation.[5,7] Dogs presenting with tracheal collapse often have a history of chronic waxing and waning respiratory difficulty or coughing that has progressively worsened over time.[8] The cough is usually paroxysmal and has been historically described as a "goose honk."[4,5,7–9] Other reported presenting signs include gagging while eating or drinking, mild to severe exercise intolerance, and severe respiratory distress, including cyanosis.[4,5,7–9] Obesity is often a contributing factor in many dogs presenting with tracheal collapse and severe clinical signs.[10]

Aggressive medical therapy should always be pursued before performing surgery to manage tracheal collapse.

CAUSE AND PATHOPHYSIOLOGY

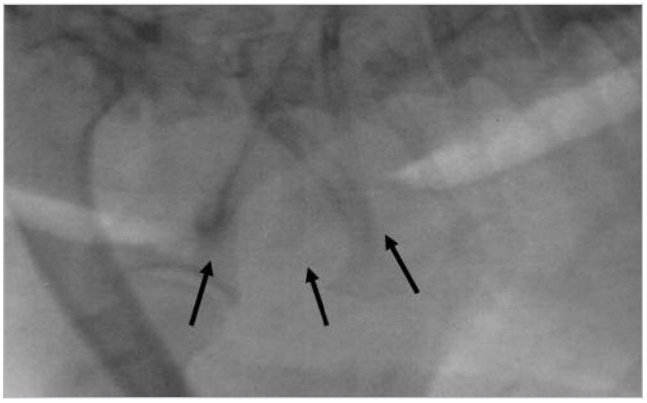
The cause of tracheal collapse is not completely understood but is likely multifactorial. The affected cartilaginous rings and dorsal trachealis muscle are less turgid than normal, interfering with the structural integrity of the tracheal wall.[11] This instability is attributed to deficiency in many of the cellular components of the normal trachea and is thought to be a manifestation of a more generalized chondrodystrophy.[12,13] Hyaline cartilage found in the trachea of normal dogs and cats contains glycoproteins, proteoglycans, and polysaccharide elements.[14,15] Glycosaminoglycan macromolecules bind water and are responsible for 95% of the weight of the cartilage. These components give the cartilage arcs of the trachea their turgidity.[11,15,16] Studies[11,14] have shown that in canine collapsed tracheal cartilage there are decreased amounts of glycosaminoglycans and glycoproteins to bind water, leading to uncharacteristic compliance and decreased rigidity of the tracheal rings. Diseased tracheal cartilage also contains less chondroitin sulfate and calcium than does normal cartilage.[11] These deficiencies lead to the replacement of normal hyaline cartilage with collagen and fibrocartilage, subsequent weakening of the rings, and collapse.[11]

Cardiac disease, bronchitis, recent endotracheal intubation, respiratory infection, hyperadrenocorticism, and cervical trauma have all been implicated as causes of tracheal collapse.[5,7] These causes are usually related to chronic coughing and increased airway resistance.[5] Increased airway resistance is commonly caused by the dorsal tracheal membrane being drawn into the tracheal lumen during the respiratory cycle.[7] Some patients may exhibit clinical signs of tracheal collapse without evidence of the causes just mentioned. Progression of the clinical syndrome may be influenced by chronic tracheal inflammation, fibrosis, and loss of the mucociliary apparatus.[7] Respiratory tract irritants such as cigarette smoke or other pollutants can exacerbate clinical signs. Laryngeal paralysis, paresis, or collapse may lead to structural changes of the trachea and have reportedly been present in 30% of cases of tracheal collapse.[17] However, in our opinion, laryngeal disease is uncommon in patients with tracheal collapse and is not the primary cause.

PHYSICAL EXAMINATION

Animals with tracheal collapse may appear normal during physical examination or may show varying degrees of respiratory difficulty. Abnormal examination findings associated with respiratory difficulty include labored breathing, abnormal respiratory sounds (e.g., stertor, coughing, wheezing), tachypnea, intermittent expectoration, hyperthermia, and pale or cyanotic mucous membranes. Altered states of consciousness are also possible, signs of which include restlessness, anxiety, delirium, and intermittent syncopal episodes.[8,9] Dyspnea is mainly inspiratory with cervical disease and expiratory with intrathoracic disease. The cervical trachea collapses during inspiration because of decreased pressure within the trachea, whereas the thoracic trachea collapses during expiration or coughing because of increased intrathoracic pressure.[7] Obesity compromises respiratory capacity and function and may exacerbate clinical signs.[9]

Figure 1. Radiographs of tracheal collapse.



Left lateral radiograph of a dog with tracheal collapse (*arrows*). The dog is awake and at rest. The area of collapse begins at the thoracic inlet and continues into the intrathoracic trachea.

Left lateral radiograph of the same dog while coughing. Note the buckling of the trachea at the thoracic inlet and the severe collapse (*arrows*).

Auscultatory findings from the lungs may be within normal limits or reveal increased bronchovesicular sounds or crackles. Crackles are often auscultated when chronic bronchitis is present because of mucus plugging and airway closure.[8]

Tracheal auscultation and palpation are important aspects of the physical examination and may lead to a preliminary diagnosis. Animals with tracheal collapse often produce harsh or wheezing sounds due to turbulent airflow.[8,9] An end-expiratory "snap" can also occasionally be heard during forceful expiration.[8] Tracheal palpation may elicit a cough, and prominent dorsolateral edges along the affected tracheal rings may be evident.[8,9]

DIAGNOSIS

The history, signalment, and physical examination findings are often strongly suggestive of tracheal collapse, but a thorough diagnostic evaluation should be completed, including hematologic testing, electrocardiography, diagnostic imaging, and, potentially, laryngeal examination and endoscopic evaluation, including collection of microbiologic and cytologic samples. These diagnostic tests should be conducted to rule out other causes of airway disease, such as brachycephalic airway syndrome, laryngeal disease, tracheobronchitis, heartworm disease, pulmonary disease, tracheal stenosis, tracheal neoplasia, upper airway foreign body, and cardiac disease. Laryngeal examination and endoscopy require sedation or general anesthesia. In patients with tracheal collapse, anesthesia can be life threatening. Clinicians should carefully consider whether these two diagnostic procedures are necessary and whether the risk associated with anesthetic induction is warranted.

A complete blood cell count and serum biochemistry profile are important in screening for concurrent disease processes and in preanesthetic evaluation. An inflammatory leukogram may suggest stress or pneumonia.[8] An elevated eosinophil count may indicate bronchitis, heartworm disease, larval migration, severe tissue damage, eosinophilic pneumonia, or other disease processes.[8] A serum biochemistry profile indicates the overall health status of a patient, may suggest possible concurrent disorders, and may aid in later anesthetic and therapeutic decisions.[8]

Radiography, fluoroscopy, and tracheobronchoscopy are useful in identifying patients with tracheal collapse. Radiography may be limited in confirming and determining the extent of tracheal collapse (Figure 1), correctly identifying the disease in only 59% of patients.[17] However, radiography may be useful in identifying concurrent pulmonary or cardiac disorders.[8] The most useful radiographic projection includes a lateral radiograph of the entire trachea taken during the maximum inspiratory and expiratory phases. In patients with cervical tracheal collapse alone, the thoracic trachea should appear normal on lateral inspiratory radiographs. With isolated thoracic collapse, the thoracic trachea should appear collapsed during expiration and the cervical trachea should appear normal.[9] Some authors[7,9] also recommend a tangential, rostrocaudal (skyline) projection of the thoracic inlet. In this projection, the abnormally flattened trachea is often seen as a C or crescent shape and, in severe cases, may be seen as only a slit-like projection.[7,18]

Dynamic imaging modalities such as fluoroscopy may be necessary to determine the full extent of the disease. Fluoroscopy allows real-time evaluation of the trachea and mainstem bronchi under varying airway conditions. The dynamic changes observed with fluoroscopy include fluttering of the dorsal membrane during expiration, inspiration, and bouts of coughing.[7,9] Evaluation of the entire trachea is important when conducting

these studies, and we strongly recommend eliciting a cough during fluoroscopy when possible.

Endoscopic evaluation of the airway can be an important step in both the diagnosis and grading of tracheal collapse and is considered by many to be the "gold standard"[7] (Figure 2). The grades range from I to IV and are determined by the percentage of reduction in tracheal lumen size and laxity of the dorsal tracheal membrane[19] (Table 1). Tracheobronchoscopy allows full evaluation of the structure and integrity of the trachea and bronchi. It also permits sample collection for microbiologic and cytologic evaluation, which is particularly important in patients with evidence of lower airway disease. Unfortunately, general anesthesia is required for tracheobronchoscopy, which is dangerous in some patients with underlying respiratory difficulties. We do not routinely use tracheobronchoscopy to diagnose tracheal collapse because of the risks associated with anesthetic induction and the accuracy of diagnosis with less-invasive imaging modalities. If tracheobronchoscopy is necessary, a thorough laryngeal examination should always be performed before intubation and the clinician should be prepared for potential respiratory complications during anesthetic recovery. If possible, laryngeal or bronchial abnormalities should be identified to give the client an accurate prognosis before treatment.[9]

When a patient with tracheal collapse recovers from anesthesia or sedation, respiratory distress is always possible and adequate facilities and protocols for handling such emergencies should be readily available.[8] This may include prolonging extubation; the use of postanesthetic tranquilizers; patient recovery in a cool, quiet, oxygen-enriched environment; and the availability of temporary tracheostomy sets and endotracheal tubes. Once all diagnostic steps have been completed, the clinician can make an informed decision about how to medically and/or surgically manage the patient's tracheal collapse.

MANAGEMENT

Medical and/or surgical treatments have been implemented for tracheal collapse with varying degrees of success. Because of the multifactorial nature of the disease, it is important to identify and correct inciting causes of tracheal collapse or concurrent diseases when possible.

Medical Therapy

Animals with tracheal collapse often present in respiratory distress and must be treated as medical emergencies. Because these patients are often unstable, unnecessary diagnostics should be postponed and stress minimized until the patient is breathing comfortably. Oxygen therapy may initially be administered by less-invasive means, including face mask, nasopharyngeal tube, or oxygen cage.[9] Mild sedation or tranquilization can help relax patients and improve ventilation. Many patients with tracheal collapse present with severe anxiety from impaired respiration; this, in turn, causes them to take rapid, shallow breaths. Sedation enables the patient to take slower breaths and optimize tidal volume. Commonly used sedatives, tranquilizers, and corticosteroids are listed in Table 2 and include acepromazine, morphine, butorphanol, diazepam, dexamethasone, and prednisolone sodium succinate.[7–9,20] Laryngeal edema and tracheal inflammation are common sequelae to increased respiratory effort associated with tracheal collapse patients in distress. Patients with severe partial upper airway obstruction rarely acquire secondary noncardiogenic pulmonary edema and may benefit from intermittent furosemide in the short term.[21] If a patient remains in respiratory distress, more invasive procedures, such as endotracheal intubation, may be necessary to ensure proper ventilation and adequate oxygenation.

Chronic tracheal collapse has historically been managed with oral medications and adjunctive management strategies. Animals with tracheal collapse are routinely treated with antitussives to help alleviate bouts of coughing commonly associated with the condition (Table 3). Butorphanol and hydrocodone are commonly recommended antitussives.[7–9,20] Cough suppressants

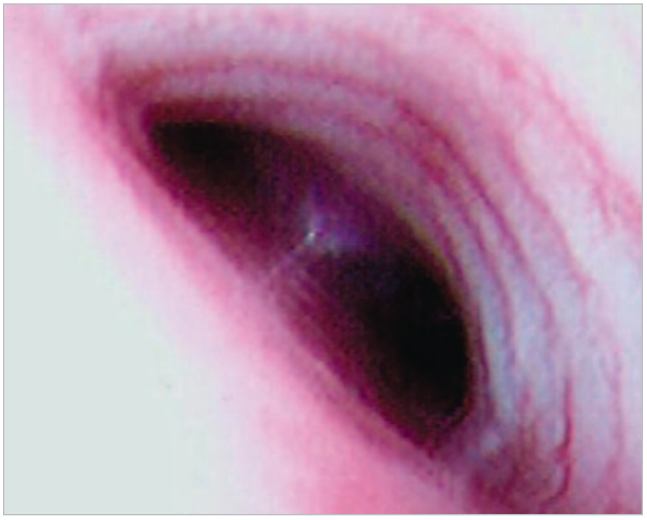


Figure 2. Tracheobronchoscopy in a dog with tracheal collapse.

Table 1. Grades of Tracheal Collapse

Grade	Tracheal Lumen	Dorsal Tracheal Membrane	Cartilage Rings
I	Reduced by 25%	Slightly pendulous	Circular
II	Reduced by 50%	Widened and pendulous	Flattened
III	Reduced by 75%	Almost in contact with the ventral lumen	Nearly flat
IV	Essentially obliterated	Lying on the luminal surface	Flat

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Table 2. Commonly Used Emergency Drugs for Tracheal Collapse

Drug	Trade Name, Manufacturer	Recommended Dose
Tranquilizers		
Acepromazine	PromAce, Fort Dodge Animal Health	0.025–0.2 mg/kg IV
Diazepam	Valium, Roche	0.2–0.6 mg/kg IV
Opioids		
Morphine	Infumorph, Baxter Healthcare	0.1–2 mg/kg SC
Butorphanol	Torbugesic, Wyeth	0.2–0.4 mg/kg SC or IV
Corticosteroids		
Dexamethasone	Azium, Schering-Plough Animal Health	0.125–0.5 mg IV or IM
Prednisolone sodium succinate	Solu-Delta Cortef, Pharmacia & Upjohn	2–4 mg/kg IV

From Plumb DC: *Plumb's Veterinary Drug Handbook*, ed 5. Ames, IA, Blackwell Publishing, 2005.

should be used with caution if a productive cough is present. If cough suppressants alone are not sufficient to control clinical signs, a bronchodilator may be added to the treatment regimen. The use of bronchodilators is controversial. The rationale for their use is based on the dilatory effects of the pulmonary airways, which decrease intrathoracic pressure and the tendency for tracheal narrowing during expiration.[7] Bronchodilators do not have a direct effect on the diameter of the trachea. Methylxanthine bronchodilators such as theophylline sustained-action capsules and aminophylline have been recommended. β_2-Adrenergic agonists such as terbutaline and albuterol have also been used as bronchodilators.[7–9,20]

Antibiotics are sometimes recommended to treat concurrent respiratory tract infections. Antibiotic selection should be based on culture and sensitivity testing and should be continued for a minimum of 14 days.[7–9] While the clinician waits for culture and sensitivity results, a broad-spectrum bactericidal antibiotic should be chosen if a respiratory infection is suspected.[9] A recent report[22] suggests that antibiotics may not be necessary in cases of tracheal collapse. Positive bacteriologic culture results in dogs with tracheal collapse did not typically involve uniform populations of bacteria and were not associated with cytologic evidence of infection or inflammation, suggesting that the bacteria were not pathogenic.[22]

Other adjunctive strategies should be used to help manage patients with tracheal collapse. Exercise restriction is important, especially in hot weather. Weight loss is an essential part of initial management.[7–9,23] The use of a body harness and removal of cigarette smoke and other inhaled allergens from the patient's environment are important.[7] Concurrent heart or pulmonary disease must be addressed appropriately before more aggressive and invasive treatment of tracheal collapse is pursued. Many feel that some affected animals suffer from allergic bronchitis and appropriate treatment may improve the associated clinical signs.

There is reportedly[10,17] a 65% to 78% success rate for medical management of tracheal collapse in dogs that do not have clinical signs for more than 12 months. The long-term prognosis is guarded, and owners must be aware that all management strategies are palliative. The goal of medical management is to control clinical signs and improve the overall quality of life. Even with aggressive medical therapy, the condition of many affected patients progressively worsens, requiring surgery or other interventional techniques.

Surgical Therapy

Medical management of tracheal collapse should always be attempted before more invasive therapies. Indications for surgical correction are not entirely clear but may include patients that have no other underlying medical conditions (e.g., cardiomegaly, pulmonary edema, bronchitis), are refractory to medical management alone, and have a grade II to IV collapse (and severe clinical signs).[9,10] The location of the collapse is also important. Surgical correction is not recommended for diffuse intrathoracic collapse because of associated surgical morbidity and is generally effective only for the cervical and very proximal portion of the thoracic trachea.[9,24,25]

Numerous techniques are described for surgical correction of tracheal collapse. Chondrotomy, plication of the dorsal tracheal membrane, and resection and anastomosis are not widely used or recommended.[9] Extraluminal prosthetics are more widely used and include total ring, pliable ring, and spiral ring prostheses.[26–31] The total ring prosthesis is currently the most widely used and recommended surgical procedure for correction of tracheal collapse. It is used to widen and support the collapsed section while preserving the segmental nerve and blood supply.[9,20,24,30]

The prostheses are created by cutting 5- to 8-mm–wide split rings from appropriately sized polypropylene syringes or syringe cases. Commercially available tracheal ring prostheses in different sizes have recently become available. It is important to avoid the segmental blood supply and recurrent laryngeal nerves when dissecting around the trachea. The prosthetic rings should be placed approximately 5 to 8 mm apart along the collapsed segment[9] (Figure 3).

The success rate of external prosthetic surgery for tracheal collapse has reportedly been 75% to 85%.[17,25] Although this is encouraging, in one report,[25] there was a 5% mortality rate and 10% laryngeal paralysis rate and 20% of patients required a permanent tracheostomy (half of which were necessary within 24 hours after surgery). Older dogs may have a worse outcome after surgical treatment regardless of the grade of collapse.[25] In the initial postoperative period, the patient should be observed closely for signs of acute respiratory distress. Supplemental oxygen, corticosteroids, or even a temporary tracheostomy may be needed to relieve clinical

Table 3. Commonly Used Drugs for Chronic Tracheal Collapse[a]

Drug	Trade Name, Manufacturer	Recommended Dose
Tranquilizer		
Acepromazine	PromAce, Fort Dodge Animal Health	0.5–2 mg/kg PO as needed
Cough suppressants		
Butorphanol	Torbutrol, Fort Dodge Animal Health	0.5–1 mg/kg PO bid, tid, or qid
Codeine	—	0.1–0.3 mg/kg PO bid or tid
Hydrocodone	Tussigon, Monarch Pharmaceuticals Hycodan, DuPont Pharma	0.22 mg/kg PO bid, tid, or qid
Corticosteroids		
Prednisone	—	0.5–1 mg/kg PO sid
Bronchodilators		
Aminophylline	Phyllocontin, Purdue Pharma	10 mg/kg PO bid or tid
Theophylline	Theo-Cap, Inwood Lab	10 mg/kg PO bid[b]
Terbutaline	Brethine, Novartis Pharmaceuticals	1.25–5 mg PO bid or tid

[a]Reprinted from Plumb DC: *Plumb's Veterinary Drug Handbook,* ed 5. Ames, IA, Blackwell Publishing, 2005; with permission.
[b]It is recommended to start at half of the recommended dose.

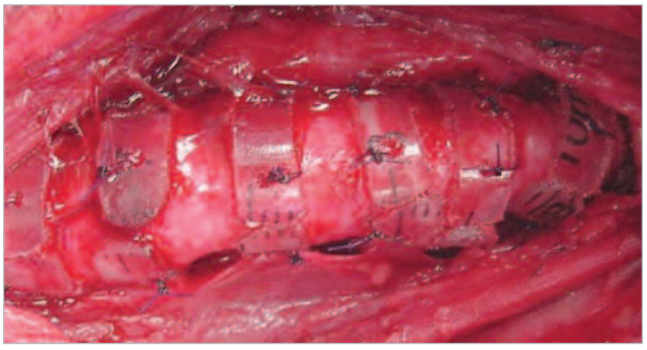

Figure 3. Intraoperative photograph of the extrathoracic trachea with prosthetic (polypropylene) rings.

Table 4. Stents for Treating Tracheal Collapse

Types	Advantages	Disadvantages
Balloon-expandable metal stents		
Palmaz (stainless steel) Strecker (knitted tubular tantalum wire)	Excellent radiopacity Excellent radial force strength Minimal foreshortening allows precise placement	Relatively low radial compression resistance allows plastic deformation if radial force is exceeded (i.e. if collapse occurs, it will not reexpand) Poor flexibility
Self-expanding metal stents		
Wallstent (woven mesh, cobalt-chromium alloy [Elgiloy, Elgiloy Specialty Metals]; up to 30% foreshortening) Nitinol (nickel–titanium alloy; negligible foreshortening) Diamond Ultraflex (open-wire, nitinol mesh; negligible foreshortening) Z-stent (stainless steel; negligible foreshortening)	Some are reconstrainable, facilitating accurate placement or removal if necessary Ability to be constrained within delivery system to a smaller diameter, facilitating placement across a stenosis without risk for dislodgement	Some are nonconstrainable Less outward radial force Foreshortening makes precise placement more difficult

signs.[9] The most common complications following tracheal surgery include coughing, dyspnea, and laryngeal paralysis.[9,19,25] Tracheal necrosis may occur if a large section of the blood supply is damaged.[32] Patients frequently cough as much or more for the first 2 to 3 weeks following surgery because of tracheitis, peritracheal swelling, and suture irritation.[9] To suppress coughing, medical management is generally continued for 2 to 4 weeks following surgery and may be necessary to administer for life.

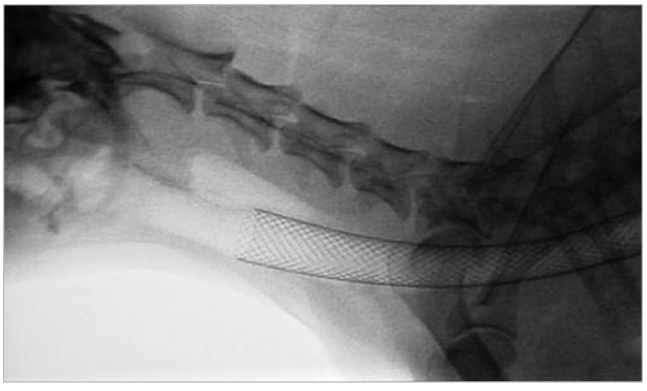

Figure 4. Left lateral radiograph of a dog with tracheal collapse after placement of an endoluminal stent (Wallstent) that spans the entire area of collapse.

Endoluminal Tracheal Stenting

The use of an endoluminal stent to treat tracheal collapse in dogs has been documented in the veterinary literature.[33–36] Indications may include patients with severe tracheal collapse that are unresponsive to medical therapy, have thoracic inlet and mainstem bronchial collapse, or have collapse of most of the trachea.[37] Currently, tracheal stenting at our institution is considered a salvage procedure in dogs with end-stage disease that are refractory to appropriate medical management, have extensive intrathoracic tracheal collapse, or are poor surgical candidates (Figure 4). Many types of stents, each with its own characteristics and limitations, are available for human use. Endoluminal tracheal stents currently used to treat tracheal collapse in veterinary medicine include devices that were originally designed for intravascular, gastrointestinal, biliary, or airway use in humans (Table 4).

Endoluminal tracheal stents have many advantages in treating tracheal collapse. Stents can be placed within the intrathoracic and extrathoracic trachea in a noninvasive fashion. Total anesthesia time is generally less than 1 hour, and placement of the stent itself often takes less than 10 minutes. Tracheal stents provide rapid and effective relief of clinical signs and are generally well-tolerated in many patients.

Stents placed in the extrathoracic trachea can be deployed as far proximal as the first tracheal ring. If multiple stents are needed, they can be placed directly adjacent to each other but should not overlap.

Reported complications of placing endoluminal tracheal stents in animals include coughing, stent migration, positive tracheal culture, pneumonia, expectoration, granulation tissue formation, squamous metaplasia, epithelial ulceration, stent collapse, deformation, acute pulmonary edema, and stent fracture.[33,34,36,38,39] Additional reported complications of nitinol stents in humans include failure to expand, stent misplacement, perforation of associated tissue, and bleeding.[40,41]

Contraindications to stent placement for tracheal collapse are relative. Active infection may be a contraindication due to theoretical impairment of the mucociliary apparatus by the presence of the stent. Alleviating or reducing chronic inflammation associated with tracheal collapse may provide the opportunity for growth of more functional tracheal mucosa through the stent. Studies examining the gross and cellular responses to self-expanding intraluminal tracheal stents are indicated.

Our experience suggests that placing self-expanding endoluminal stents can provide temporary relief from signs associated with tracheal collapse in dogs; however, stent placement is associated with various complications. We have concerns about spanning high-motion areas, such as the thoracic inlet, with a stent. Stenting across high-motion areas can lead to fatigue and, ultimately, failure of the stent. Therefore, vascular stenting across high-motion areas (e.g., joints) is routinely avoided in human interventional radiology.

CONCLUSION

Clinicians should be aware of the common clinical signs, pathophysiologic changes, diagnostic tools, and surgical techniques associated with tracheal collapse. Medical management is the mainstay of therapy. Surgical intervention or endoluminal stenting should be considered when aggressive medical management has failed. Tracheal collapse is a degenerative disease process, and therapy is aimed at palliation of clinical signs and is not curative.

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ARTICLE #3 CE TEST

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1. The blood supply to the trachea is
a. primarily from the tracheal artery.
b. from three major arteries arising from the ascending aorta.
c. a segmental supply from the cranial and caudal thyroid arteries and bronchoesophageal arteries.
d. from the internal and external carotid arteries.
e. all of the above

2. The most common signalment of dogs with tracheal collapse is
a. toy breed, castrated male, and younger than 2 years of age.
b. large breed, female, and middle aged.
c. toy breed, either gender, and older than 7 years of age.
d. toy breed, either gender, and middle aged.
e. all of the above

3. Which statement(s) regarding tracheal collapse is correct?
a. Tracheal collapse is thought to be caused by laryngeal paralysis, paresis, or collapse.
b. Laryngeal paralysis, paresis, or collapse may be predisposing factors associated with up to 30% of tracheal collapse cases.
c. Tracheal collapse is thought to result from damage to the nerves supplying the trachea.
d. Tracheal collapse is a congenital disease that is associated with other congenital abnormalities.
e. all of the above

4. Which statement(s) regarding the diagnosis of tracheal collapse is correct?
a. Radiography is limited in confirming and determining the extent of tracheal collapse.
b. Fluoroscopy is helpful in determining the full extent of tracheal collapse and can be conducted in awake patients.
c. Tracheobronchoscopy is the gold standard in identifying and grading tracheal collapse.
d. A thorough workup may include standard radiography, fluoroscopy, laryngeal examination, and endoscopic evaluation of the airway in dogs with tracheal collapse.
e. all of the above

5. Medical management of tracheal collapse should be attempted before surgical intervention and may include
a. sedatives and tranquilizers.
b. antitussives.
c. antibiotics if a concurrent respiratory infection is confirmed or suspected.
d. bronchodilators.
e. all of the above

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Tracheal Collapse *(continued from p. 382)*

6. Adjunctive treatments to the common medical therapies for tracheal collapse include

a. increasing activity level and exercise.
b. weight loss, removal of environmental allergens and irritants, and use of a body harness instead of a neck lead.
c. adding humidifiers to the dog's environment and opening the windows in the house.
d. increasing caloric intake and limiting water intake.
e. all of the above

7. Which statement(s) regarding tracheal collapse is correct?

a. Tracheal collapse has a guarded long-term prognosis.
b. Tracheal collapse cannot be cured with medical and surgical interventions.
c. A 65% to 78% success rate has been reported for medical management of tracheal collapse in dogs that have not had clinical signs for more than 12 months.
d. Many dogs with tracheal collapse require surgery or other interventions at some point in their life.
e. all of the above

8. Indications for surgical intervention in dogs with tracheal collapse include

a. the owner's desire to avoid medical management.
b. failure of medical management and no underlying medical conditions.
c. concurrent severe cardiac disease.
d. severe intrathoracic trachea or mainstem bronchi collapse.
e. all of the above

9. The commonly recommended surgical option(s) for dogs with tracheal collapse include

a. resection and anastomosis of the intrathoracic trachea.
b. chondrotomy and plication of the dorsal tracheal membrane.
c. placement of an extraluminal prosthesis.
d. a tracheal ring autograft transplant.
e. all of the above

10. Indications for endoluminal tracheal stenting include

a. severe tracheal collapse that is unresponsive to medical management.
b. intrathoracic and mainstem bronchi collapse.
c. likelihood of a poor surgical outcome.
d. a high anesthetic risk.
e. all of the above