Learning Objectives
What is the signalment and what are the clinical signs associated with collapsing trachea. What are the four grades of tracheal collapse. How is tracheal collapse diagnosed. What are the indications for surgery and what are the three basic methods devised to surgically manage tracheal collapse.

COLLAPSING TRACHEA

Background
Collapsing trachea is a disease process recognized predominately in miniature or toy breeds (Pomeranian, miniature and toy poodle, Yorkshire terrier, Chihuahuas, pug). The condition is reported in dogs of all ages, with the average being 7 years. Although the exact etiology is not known, histologically the tracheal ring cartilage is hypocellular and deficient in glycoprotein and glycosaminoglycan content. The clinical picture is variable with early signs generally mild with a productive cough and mild exercise intolerance in a normally active dog, progressing to more severe exercise intolerance and a characteristic Goose-honk cough. Dyspnea is often initiated by anxiety or excitement.

Classification of collapsing trachea:

Grade I - tracheal membrane is slightly pendulous, cartilage maintains normal shape, lumen reduced approximately 25%
Grade II - tracheal membrane widened and pendulous, cartilage is partially flattened, lumen reduced approximately 50%
Grade III - tracheal membrane is almost in contact with dorsal trachea, cartilage is nearly flat, lumen is reduced approximately 75%
Grade IV - tracheal membrane is lying on dorsal cartilage, cartilage is flattened and may invert, lumen is essentially obliterated

The result of tracheal collapse is an extremely small cross-sectional area of functional tracheal lumen and high airway resistance. Abnormal rings in the cervical trachea collapse on inspiration, while those in the thoracic trachea collapse on expiration. When the intrathoracic trachea collapses on expiration a higher expiratory pressure and an increase pulmonary vascular resistance results (cor pulmonale). This increase in resistance along with chronic hypoxia causes increased right ventricular work and can lead to enlargement (hypertrophy) of the right side of the heart.

Diagnosis
Tracheal collapse is suspected with an appropriate signalment, history and eliciting coughing reflexes with simple digital palpation of the trachea. Radiographs and fluoroscopy of the lateral cervical and thoracic trachea in an unanesthetized patient during inspiration and expiration can be diagnostic. Evaluation of laryngeal function under a light plane of anesthesia should also be performed to rule out laryngeal paralysis or laryngeal collapse. Unfortunately not all cases can be diagnosed easily and it may be necessary to elicit a cough while obtaining radiographs to demonstrate tracheal collapse. Endoscopy/tracheoscopy is an excellent technique to evaluate the trachea and bronchi and can be used to grade the degree of collapse. Cytology and culture of the airway should be obtained to determine if a bacterial component is involved. Recurrent bacterial tracheitis can occur with severe tracheal collapse.

Medical management of tracheal collapse involves symptomatic therapy using antitussive medication, corticosteroids, bronchodilators, sedatives, and weight loss. It can be effective in mild cases; however, more advanced stages of collapse (grades III and IV) usually do not respond well. Aggressive medical therapy should be attempted before surgery is considered. Agents used to control coughing at UF include butorphanol, hydrocodone and more recently Diphenoxylate and atropine (Lomotil). In times of decompensation I will often sedate the dog with acepromazine and add a low dose of prednisone to help reduce mucosal inflammation. I find that individual dogs respond differently to different agents and each dog usually ends up with a different regimen. I have little experience with glucorticoid inhalants, or bronchodilators such as theophylline or torbutaline but these are used by some.
Surgery

Three classifications of surgical procedures have been described for collapsing trachea; 1) dorsal tracheal membrane plication, 2) external tracheal prosthesis and 3) intraluminal stents. These methods provide clinical relief for varying periods of time. Surgery should not be undertaken unless the remainder of the upper respiratory system is free of disease. Correction of any other components of upper respiratory obstruction (stenotic nares, everted laryngeal sacules, elongated soft palate, laryngeal paralysis or collapse) may relieve the dyspnea sufficiently to eliminate the need for surgical correction of the collapsing trachea. Surgical therapy is also controversial with respect to efficacy. Deep thoracic tracheal and major bronchial collapse has a poor prognosis, whereas isolated cervical collapse has a fair to good prognosis for improvement. If bronchial collapse is present, surgical support of the trachea may not sufficiently alter the clinical condition. Reconstruction of one segment of the trachea may be followed by collapse of another segment.

Dorsal tracheal membrane plication has been used successfully for short term management of patients with Grade I or Grade II collapsing trachea. Eventually the trachealis muscle relaxes and the airway closes down again. Additionally if this technique is used in animals with more severe disease the plication technique can cause severe narrowing of the lumen as the tips of the cartilage rings are drawn together. For these reasons plication of the dorsal tracheal membrane has been largely abandoned as a surgical remedy for collapsing trachea in dogs.

Extraluminal prosthesis techniques were the most widely used technique until 10 years ago. Both ring and spiral prosthesis have been described for this use. Both prosthesis types can be made from syringe cases (polypropylene). The advantages of these techniques are that they do not greatly interfere with the mucociliary apparatus and dislodgement is not usually a problem. The major disadvantage of the technique is that they can only be used for extra-thoracic tracheal collapse and that the surgical approach is invasive and has the potential for severe postoperative complications including death. The goal of the technique is to provide external support to prevent collapse of the trachea without interfering with segmental motion or vascular supply. Ring prostheses are made by either making individual C-shaped rings (Hobson technique) (5-8 mm wide) or a continuous spiral prosthesis (Fingland technique). The author has also modified the spiral ring technique by cutting a silicone endotracheal tube with a spring insert and using that as the prosthesis. The internal diameter of the ring is sized according to the tracheal ring diameter. The prosthesis is applied taking great care not to interfere with the vascular or nerve supply of the larynx or trachea. The most common complications associated with extra luminal prosthesis placement. This technique has produced favorable results, however, when complications occur they can be life-threatening.

Post-op Care

Strict cage rest (oxygen if necessary), antitussives, corticosteroids if coughing persists, and appropriate antibiotics are instituted in the postoperative period. The immediate post-op recovery period can be challenging, especially if laryngeal paralysis has resulted from recurrent laryngeal nerve damage.

Complications

Intraluminal hemorrhage (suture penetration), peritracheal swelling/inflammation, damage to the recurrent laryngeal nerve resulting in laryngeal paralysis and tracheal necrosis and slough from ischemia if the blood supply to the trachea is severely compromised. If paralysis occurs, surgery (laryngeal tieback) is usually necessary for survival. Coughing usually improves several weeks after after surgery; however, this procedure does not usually make these dogs normal.

Intra Luminal Tracheal Stents: The Pros and Cons

Advantages and disadvantages

Intraluminal tracheal stents are best reserved for dogs with tracheal collapse that are not good candidates for extraluminal prosthesis and have failed medical therapy. They can be placed in dogs with intra thoracic tracheal collapse and the main contraindication to their use is in dogs with collapse of the main stem bronchus. They offer the advantages of minimally invasive deployment, short postoperative convalescence and rapid restoration of airway lumen. When properly sized and appropriately deployed the short term improvement in respiratory function is truly remarkable. Postoperative coughing is never totally alleviated since the stent interferes with the mucociliary clearance of sputum and predisposes the patient to lower airway infection. Unfortunately because of their location they are also subject to severe cycling and bending forces. Consequently the stent is prone to kinking and the tracheal wall is prone to granuloma formation at the rostral and caudal extents of the stent. Additionally these stents are impossible to remove after deployment to adjustment of broke unit is not possible. Fortunately fractured stents lend themselves to
repair by telescoping of a new stent through the kinked or fractured region. I advise owners that tracheal stents should be deployed as late in the animals’ life as possible since few patients live more than 2-3 years without developing significant complications.

**History of Tracheal Stents in Dogs**

Until recently all attempts at intraluminal tracheal stents for tracheal collapse in dogs have used human implants that were specifically designed for use in the alimentary tract the urogenital tract or the bronchi. Although these units are flexible they were not made for the degree of constant flexion and extension and cycling that occurs in the dogs’ thoracic inlet. Consequently deformation, kinking and fatigue fracture of the implant have been something veterinary surgeons have struggling to overcome since their first use in the early 90’s. The first attempts at intraluminal stenting in dogs utilized a balloon expandable Palmaz stent. There were many difficulties with this unit the most notable being migration and coughing up of the stent. Subsequent to this the self expanding biliary Wall stent was used to successfully treat tracheal collapse. This unit created a good initial dilation of the tracheal but was subject to kinking, fracture and was also a bit stiff causing granuloma formation on either end of the unit. At UF we converted to the Ultraflex unit created by Boston scientific in the late 90’s This unit was made with highly flexible woven nickel titanium alloy (Nitinol) and was very deformation and fracture resistant. However problems developed when the company switched to a proximal deployment format. This made proper placement of the unit very difficult due to the inherent bowing that the catheter underwent during deployment. Additionally the unit was very expensive costing in the neighborhood of $2800 USD. Recently veterinary surgeons have teamed with MD’s to develop Infiniti Medical which is a MIS company specializing in many types of deployable stents. The website is [http://www.infinitimical.com/](http://www.infinitimical.com/) Their tracheal stents are laser cut Nitinol stents and are deployed using a retractable outer polypropylene sleeve making them reconstrainable. Additionally the 8 Fr deployment catheter size makes them easy to deploy thru and endotracheal tube greatly adding to the safety of the patient. Also the stent cost is roughly one half of the cost of the human units.

**Stent measurement and Deployment**

Proper sizing of the shunt is critical to proper success with this technique. We see the dog for workup visit and measurement of the collapse under fluoroscopy. Sizes are available on the company’s website. I personally order a stent 2-3mm larger than the diameter of the normal intra thoracic trachea adjacent to the collapse. Do not order a stent that is too long because if it does not fully expand it will not shorten adequately. You must not deploy the stent closer than 15 mm to the main stem bronchus distally or closer than 15 mm from the larynx proximally. The animals typically wake up without difficulty and are managed with antitussives prednisone and acepromazine overnight. They typical are discharged the following day and are continued on heavy antitussive therapy for at least one month post deployment. After this coughing tends to reduce somewhat. An excellent animation of the stent deployment procedure can be found at [http://www.infinitimical.com/p_stents.html](http://www.infinitimical.com/p_stents.html).

**REFERENCES**