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UPDATE ON LARYNGEAL PARALYSIS AND COLLAPSING TRACHEA

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Abstract
The causes of laryngeal paralysis remain unknown but result in bilateral loss of function of the recurrent laryngeal nerves. This prevents abduction of the arytenoid cartilages during the inspiratory phase of the respiratory cycle. Surgical treatment typically entails lateralization of one of the arytenoid cartilages. Although this will improve respiratory function, owners must be warned of the potential for postoperative aspiration pneumonia. The causes underlying collapsing trachea are similarly unknown. This disorder can affect any portion of the trachea and can extend to the bronchi. Management of tracheal collapse by weight loss or medication is preferable to surgery due to the relatively high rate of postoperative complications. External rings can be surgically applied to the cervical trachea. Internal stents relieve symptoms of collapsing trachea but are accompanied by a number of potential complications, including chronic cough, ingrowth of excessive granulation tissue, and migration or fracture of the stent.

Laryngeal Paralysis
Laryngeal paralysis may occur in either dogs or cats. Laryngeal paralysis occurs far more frequently in dogs, and there appears to be a predisposition within the Labrador Retrievers. Laryngeal paralysis has been reported to be a heritable trait in Siberian Huskies and Bouviers des Flandres.

Laryngeal paralysis in dogs and cats must be bilateral to cause clinical disease. The cause of laryngeal paralysis is unknown in the vast majority of cases. Recent reports provide strong evidence that laryngeal paralysis may be a manifestation of generalized polyneuropathy [1,2] and further that laryngeal paralysis is frequently accompanied by esophageal dysfunction at the time of diagnosis [3]. No correlation has been established between metabolic disorders, such as abnormal thyroid function, and laryngeal paralysis. Treatment of concurrent systemic illness rarely, if ever, results in recovery of laryngeal function. Laryngeal paralysis can also arise from iatrogenic injury to the recurrent laryngeal nerves during surgery or from neck trauma.
Diagnosis
Symptoms frequently include a change in character or volume of vocalization, increased noise associated with respiration, coughing, and occasionally syncope. Dogs with laryngeal paralysis can develop extreme, life-threatening respiratory distress. Laryngeal paralysis can limit inflation of the lungs, and the resultant atelectasis may be misinterpreted as organic lung disease. Initial treatment for these animals entails sedation and administration of supplemental oxygen. In some animals, it may be necessary to induce general anesthesia and pass an endotracheal tube or perform a tracheostomy on an emergency basis.

The diagnosis of laryngeal paralysis is made by direct observation of the movement of the larynx while the animal is lightly anesthetized. It is vital that the animal continue to breathe spontaneously during the examination. In coordination with inspiration, the arytenoid cartilages should be abducted (move in a lateral direction). The arytenoid cartilages will typically remain in a neutral position but may passively adduct during inspiration (paradoxical movement).

Treatment
Although resection of the vocal folds or partial arytenoidectomy have been recommended for treatment of laryngeal paralysis, these techniques are not consistently effective and can be associated with a significant incidence of complications.

Unilateral arytenoid lateralization is the procedure used by most surgeons. This entails placing sutures through the muscular process of one of the arytenoid cartilages and securing the arytenoid cartilage in a lateral position by passing the suture through the cricoid cartilage. The anatomy of the larynx can be extremely confusing, and successful performance of this surgery requires experience. The cartilages of the larynx are extremely delicate in small dogs and cats, and sutures placed to fix the arytenoid cartilage in a lateral position can easily pull through the cartilage. Tracheostomy is not routinely performed in conjunction with arytenoid lateralization.

The arytenoid cartilages are often mineralized and brittle in older dogs and may be fragile in small dogs and cats. Passage of the needle through the arytenoid cartilage in these animals may split the cartilage. Should this occur, three options exist: 1. Place a loop in the form of a half-hitch or knot around the muscular process of the cartilage and draw it tight to secure the suture to the cartilage; 2. Reposition the animal and perform the surgery on the other side of the larynx; or 3. Select another method of treatment.

The results of fixing the arytenoid cartilage in a lateral position should be evaluated during or after surgery. Since airway resistance is inversely proportional to the fourth power of the radius, what appears to be a relatively small increase in the opening of the larynx can significantly increase airflow.

Potential complications of this procedure include abscess formation as a result of perforation of the laryngeal mucosa during surgery, failure to improve, or aspiration of food and water. Postoperative infection is uncommon and usually responds to antibiotic therapy. Should the animal fail to improve after surgery, the procedure can be performed bilaterally. However, the owner should be warned this increases the potential for aspiration. As mentioned previously, abnormal esophageal function is not uncommon in dogs with laryngeal paralysis, and this greatly increases the risk of aspiration.

It is possible to effectively treat aspiration pneumonia in the absence of megaesophagus. Aspiration will subside in some dogs over time after surgery. Varying the consistency of the food or raising the position of the water bowl has also proven effective in diminishing aspiration in some animals. However, owners should be warned prior to surgery aspiration is a potential complication of this procedure. If aspiration is extremely severe
in the early postoperative period, the sutures could be removed from the arytenoid cartilage and the procedure performed on the contralateral side. Should this be done, the owner should be warned that the cartilage may be substantially weakened and could collapse. Coughing which occurs after arytenoid lateralization usually does not persist beyond 7-10 days. Owners should be informed prior to surgery that arytenoid lateralization will alter vocalization.

**Tracheal Collapse**

Tracheal collapse is observed most often in middle-aged and older toy and miniature breeds but has been described in young, large breed dogs and cats. The exact causes of tracheal collapse are unknown. Tracheal collapse may be associated with relatively mild structural changes such as ventral depression of the dorsal longitudinal ligament or severe deformity of the cartilages resulting in nearly complete ventral-dorsal occlusion of the affected portion of the trachea. Tracheal collapse may be confined to an isolated portion of the trachea or may encompass the entire trachea and bronchial tree. If the bronchi are involved, this is often referred to as bronchomalacia, and surgical treatment will not be effective.

**Diagnosis**

Clinical signs may vary from increased noise emanating from the upper airways or profound dyspnea accompanied by a “honking” cough. Dyspnea and coughing are often triggered by activity, excitement, or stress. During physical examination, it is often possible to initiate coughing by firm palpation of the cervical trachea.

The breed, history, and physical examination may suggest tracheal collapse, and a definitive diagnosis is made by endoscopy or radiography. If the trachea and bronchi are evaluated by radiography, it is ideal to view these structures during the respiratory cycle with fluoroscopy. If the cervical area is primarily affected, the trachea will collapse during the inspiratory phase of the respiratory cycle due to negative intratracheal pressure. The intrathoracic trachea will usually collapse during expiration, if affected. Dynamic collapse of the bronchi may be observed during expiration or coughing.

**Treatment**

Nonsurgical management of tracheal collapse should include weight loss and alterations of the animal’s environment to minimize stress. Medical therapy, including sedation, cough suppressants, bronchodilators, and steroids may also be helpful. Surgical correction of tracheal collapse is typically not recommended until medical management has proven ineffective. Sedation is used only occasionally during periods of extreme stress and can be achieved by using a low dose of acepromazine (0.025 mg/kg) or diazepam (0.5 mg/kg). Cough suppressants that are effective in some of these dogs include butorphanol (0.1 mg/kg q 6-12 hr) or hydrocodone (0.22 mg/kg q 4-8 hr). Bronchodilators do not affect the trachea or large airways but may decrease total resistance to airflow. Theophylline in a formulation that has a longer duration of action (Theo-Dur® or Slo-bid®, 20-40 mg/kg q 12 hr) can be helpful in these dogs. Corticosteroids should only be used intermittently to decrease acute inflammation (prednisolone 0.5 mg/kg q 12 hr for 4-7 days followed by 0.5 mg/kg q 24 hr for 4-7 days, and 0.5 mg/kg q 48 hr for 4-7 days).

If dogs fail to respond to medical management, surgery can be considered. Surgical options for treatment of tracheal collapse include application of plastic rings to the external surface of the trachea or insertion of intraluminal stents. Both procedures have a relatively high rate of complications, and the owner should be made aware of these prior to performing either procedure.
Plastic rings for external application to the trachea are commercially available (New Generation Devices, 65 Harristown Road Glen Rock, NJ 07452 USA; phone 201-891-5615, fax 201-891-5715; http://newgenerationdevices.com/index.cfm). The blood supply of the trachea is segmental, and openings large enough to allow passage of the ring should be created in the adventitia around the trachea at approximately 1.5 cm intervals. As each ring is positioned, it is secured to the trachea using 4 to 6 4-0 polypropylene sutures passed through the holes in the plastic ring and around a cartilaginous ring of the trachea. One or more sutures should also be placed through the trachealis muscle. When these sutures are tightened and tied, the trachea is fixed in an open position. A sufficient number of rings should be placed to span the area of collapse.

One disadvantage of placement of plastic rings for treatment of tracheal collapse is that their placement is limited to the cervical trachea. Care must also be taken to preserve the recurrent laryngeal nerves, and laryngeal paralysis has been reported as a complication of this technique. Other potential complications include continued coughing or collapse of the trachea (or bronchi) in areas not spanned by the rings.

Intraluminal stents were initially developed to treat vascular stenosis or airway narrowing in humans. Advantages of the use of intraluminal stents for treatment of tracheal collapse in dogs is that these can be applied within the intrathoracic trachea. Disadvantages include persistent coughing due to irritation induced by the stents, migration of the stents, fracture of the stents, or production of excessive granulation tissue within the lumen of the trachea that may result in partial obstruction. Selection of the proper size stent to use is crucial. Ideally, lateral radiographs should be made while the animal is anesthetized. The length of trachea that is collapsing should be determined and the maximal diameter of the trachea when airway pressure is held at 20 cm H2O is measured. It is helpful to place a measuring device with radiopaque length markers in the esophagus prior to making radiographs. This will allow accurate measurement of the trachea and compensate for distortions in size that may occur when radiographs are made. The size of stent should exceed the maximal diameter of the trachea by 10-20%, and the stent should be 1-2 cm longer than the area of collapse. If necessary, multiple stents can be placed. Placement is observed using a bronchoscope or fluoroscopy, and when the stent is deployed, it expands to the size and length indicated by the manufacturer. Veterinary-specific stents are available from Infiniti Medical, LLC (22741 Pacific Coast Highway, Suite 230, Malibu, CA 90265, USA; phone 310-295-1151, fax 310-388-5254: http://www.infinitimedical.com/

References