The laryngeal functions are to regulate airflow, voice production, and prevent inhalation of food. If the intrinsic muscles and/or the nerve supply of the larynx are not normal, laryngeal function is not normal.

The cricoarytenoideus dorsalis muscle abducts the arytenoid cartilages at each inspiration. The laryngeal recurrent nerve innervates this muscle. Lesions to the laryngeal recurrent nerve or to the cricoarytenoideus dorsalis muscle result in laryngeal paralysis in dogs and cats. Laryngeal paralysis can be unilateral or bilateral.

Etiology
Congenital and acquired forms of laryngeal paralysis have been recognized in dogs and cats.

Congenital Laryngeal Paralysis
Congenital laryngeal paralysis has been reported in Bouviers des Flandres, bull terriers, Dalmatians, rottweilers, and huskies. Bouviers des Flandres and bull terriers have mostly been reported from Europe, the Dalmatians and huskies from the United States. Laryngeal paralysis has a hereditary transmission in Bouvier des Flandres with an autosomal dominant trait. Wallerian degeneration of the laryngeal recurrent nerves and abnormalities of the nucleus ambiguus are both present. Dogs with congenital laryngeal paralysis are clinical at an earlier age (before 1 year old) than dogs with acquired laryngeal paralysis.

Acquired Laryngeal Paralysis
Acquired laryngeal paralysis is most commonly reported in Labrador retrievers, golden retrievers, St. Bernards, and Irish setters at 9 years old. It has been reported in cats. Acquired laryngeal paralysis is more frequently idiopathic; however, other causes should be ruled out. Diseases and conditions may contribute to laryngeal paralysis. A cranial mediastinal or neck mass stretching or compressing the laryngeal recurrent nerves can induce a laryngeal paralysis. Trauma to the laryngeal recurrent nerve during dogfights or surgery in the neck is a cause of laryngeal paralysis. Laryngeal paralysis in the cat has been diagnosed after bilateral thyroidectomy. Finally, neuropathy involving the laryngeal recurrent nerve or myopathy involving the intrinsic muscle of the larynx, and endocrine insufficiency (hypothyroidism) that can induce a polyneuropathy or a polymyopathy, are other causes of laryngeal paralysis in the adult dog.

Clinical Findings

History
The presenting signs are similar for the congenital and acquired forms. Progression of signs is often slow; months to years may pass before an animal develops severe respiratory distress. Early signs include change in voice, followed by gagging and coughing, especially during eating or drinking. Endurance decreases and laryngeal stridor (especially inspiratory) increases as the airway occlusion worsens. Episodes of severe difficulty breathing, cyanosis, or syncope occur in severely affected patients. Male dogs are approximately 3 times more affected than female. Laryngeal paralysis can be accompanied with various degrees of dysphagia, which significantly enhances the probability of aspiration after surgical correction of the laryngeal paralysis.

Physical Examination
The physical examination of dogs with laryngeal paralysis is fairly unremarkable. Dogs have difficulty breathing on inspiration that is not alleviated with open-mouth breathing. Mild lateral compression of the larynx significantly increases inspiratory effort. Referred upper airway sounds are present during auscultation of the thoracic cavity. Auscultation of the thoracic cavity and the lung field may reveal the presence of pneumonia in the cranial lung lobe due to aspiration. Palpation of the muscle mass may reveal skeletal muscle atrophy in cases of polyneuropathy. The tibial cranial muscle is very commonly atrophied in dogs with endocrine polyneuropathy. A complete neurologic examination is required to evaluate the animal for a polyneuropathy.

Laboratory Findings
Complete blood count and chemistry profile are usually within normal limits. Hypercholesterolemia, hyperlipidemia, and augmentation of liver enzymes activity are present on the chemistry profile for dogs with
hypothyroidism. A thyroid profile with endogenous TSH and free T4 is then required to further define the diagnosis. Laryngeal paralysis has inconsistent correlation with hypothyroidism.

Radiographic Examination
It is necessary to perform a radiographic examination of the thoracic cavity for the evaluation of the lung parenchyma and the esophagus. Aspiration pneumonia is a common finding preoperatively in dogs with laryngeal paralysis. If aspiration pneumonia is present, the surgical intervention should be delayed until the aspiration pneumonia resolves. Megaesophagus might be present in dogs with laryngeal paralysis, especially if the paralysis is due to polynuropathy or polymyopathy. Megaesophagus places the animal at more risk for aspiration pneumonia after surgery. Radiographic examination of the larynx is unremarkable.

Laryngeal Examination
A laryngeal examination under general anesthesia is required for the diagnosis of laryngeal paralysis. A light plane of anesthesia is required to be able to evaluate the laryngeal function during each inspiration. Thiopental or propofol is used intravenously as needed for the anesthesia. The animal should be anesthetized to the point at which the mouth can be opened easily and a laryngeal reflex is still present. If the animal is too deeply anesthetized the larynx looks paralyzed even in the normal animal. If the plane is too deep it is important to let the animal approach consciousness and examine the laryngeal function during this time. During the laryngeal examination, motion of the arytenoid cartilage is observed during inspiration. Dopram intravenously can be used to stimulate the central respiratory center and have a better laryngeal examination. The animal should be placed in sternal recumbency and the head elevated to the level that it is normally carried. In the normal animal the vocal fold and the arytenoids should abduct during inspiration and passively relax during expiration. The arytenoid cartilages and the vocal cords are immobile and drawn toward midline during inspiration if the animal has laryngeal paralysis. If the paralysis is unilateral only one cartilage is not moving. Edema and erythema of the mucosa of the arytenoid cartilages are present on the dorsal part of the larynx and appear to be due to repeat trauma of the arytenoid touching each other at each inspiration.

Treatment
Emergency Treatment
Animals are usually presented with acute cyanosis or collapse as a result of upper airway obstruction. Most animals in a cyanotic crisis precipitated by upper airway obstruction recover initially with medical therapy. Excitement or increase in the ambient temperature can trigger an acute onset of inspiratory dyspnea. Excitement or increase in the ambient temperature increases the respiratory rate, which results in trauma to the mucosa of the arytenoid cartilage. Inflammation and acute swelling of the mucosa of the arytenoid cartilages can exacerbate the chronic airway obstruction and induce an acute onset of inspiratory dyspnea. A vicious circle is then initiated.

Corticosteroids are given intravenously (dexamethasone, 0.2 to 1.0 mg/kg BID) to reduce laryngeal inflammation and edema. At the same time, oxygen is administered by mask or oxygen cage to alleviate hypoxia. Hyperventilating hyperthermic animals (temperature > 105°F) must be cooled with an alcohol or ice water bath. Sedation with acepromazine intravenously is indicated (0.1 mg/kg with a maximum dose of 3 mg) if the animal is still stressed. Fluid therapy is administered with caution, because some animals with severe upper respiratory tract obstruction develop pulmonary edema. Diuretics are indicated in these patients. If the patient condition is deteriorating, an emergency tracheostomy is recommended to bypass the upper airway.

Surgical Treatment
Laryngeal surgery is directed at removing or repositioning laryngeal cartilages that obstruct the rima glottidis. The 4 currently recognized surgical procedures used to correct laryngeal paralysis are (1) unilateral or bilateral arytenoid cartilage lateralization, (2) ventricular cordectomy and partial arytenoidectomy via the oral or ventral laryngotomy approach, (3) modified castellated laryngofissure, and (4) permanent tracheostomy. Arytenoid cartilage lateralization is currently the most common surgical treatment.

Arytenoid Cartilage Lateralization
This procedure has been used successfully to treat laryngeal paralysis in cats and dogs. Arytenoid lateralization has been performed bilaterally or unilaterally. Unilateral arytenoid lateralization is sufficient to reduce clinical signs of
laryngeal paralysis. A unilateral lateralization can be performed through a ventral or lateral incision. It is our preference to perform lateralization through a lateral incision.

The animal is positioned in lateral recumbency for a unilateral lateralization, and a skin incision is made over the larynx just ventral to the jugular groove. The sternohyoid muscle is retracted ventrally to expose the lateral aspect of the thyroid and cricoid cartilages. The larynx is rotated to expose the thyropharyngeal muscle, which is transected at the dorsocaudal edge of the thyroid cartilage. The wing of the thyroid cartilage is retracted laterally, and the cricothyroid junction may be incised. Incision of the cricothyroid joint gives a better exposure, but it is not always needed. Its transection might reduce the diameter of the rima glottidis after arytenoid abduction. The cricoarytenoideus dorsalis muscle or the fibrous tissue left is dissected and transected. The cricoarytenoid articulation is detached from caudal to cranial with Metzenbaum scissors. The sesamoid band connecting the arytenoid cartilages dorsally is left intact. However, dorsal displacement of the arytenoid results and creates distortion of the rima glottidis. The disarticulated arytenoid cartilage is only attached to the vocal cord, aryepiglottic fold, and laryngeal mucosa. Invasion through the laryngeal mucosa is avoided.

The arytenoid cartilage is sutured to the caudo-dorsal part of the cricoid cartilage. This provides an adequate laryngeal airway with only a unilateral tieback. Placement of the suture on the caudo-dorsal part of the cricoid provides a physiologic position of the suture. One 2-0 nonabsorbable suture is placed in a simple interrupted suture pattern from the muscular process of the arytenoid cartilage to the caudo-dorsal edge of the cricoid cartilage and tightened to maintain the arytenoid in position. The amount of tension on the suture should be limited to avoid over-abducting the arytenoids cartilage. In cats, it is recommended to use small suture material (3-0 or 4-0) mounted on a pledget to prevent tearing through the cartilage. The arytenoid cartilage does not need to be displaced caudally. It is the authors’ impression that the arytenoid cartilage needs only to be maintained in position and stabilized at inspiration. The wound is closed by suturing the thyropharyngeal muscle and routinely closing the subcutaneous tissue and skin.

At the time of extubation it is important to observe per os the size of the laryngeal opening achieved to ensure that adequate abduction of the laryngeal cartilages has been obtained. Excessive abduction may lead to aspiration of food or fluid.

Complications associated with laryngeal lateralization include aspiration pneumonia, persistent cough exacerbated after drinking, seroma, and breaking of the suture and fragmentation of the arytenoid cartilage. Breaking of the suture and fragmentation of the cartilage induce recurrence of the clinical signs of laryngeal paralysis. Laryngeal lateralization should then be performed on the other side. If the procedure has been performed bilaterally a partial laryngectomy needs to be performed. Seroma formation is very common and is self-limited. Aspiration pneumonia is present in 10 to 15% of the cases. Dogs are at risk for aspiration pneumonia during the rest of their life. The incidence of aspiration pneumonia is more common in bilateral laryngeal lateralization compared to unilateral. In a study, 42% of the dogs with bilateral lateralization experienced an episode of aspiration pneumonia.

Metoclopramide can be used to try to reduce the incidence of regurgitation and aspiration pneumonia in the perioperative period. Limited utilization of opioids is also recommended to allow sternal recumbency as soon as possible after surgery. A local skin block with bupivacaine might be valuable to control pain postoperatively and minimize the utilization of opioids. Water and food should be completely withdrawn after surgery for 24 hours. Two or three meatballs should be delivered 24 hours after surgery under constant direct supervision. If the animal can handle meatballs without aspirating, ice cubes and then water can be delivered. The animal should be closely watched for the next 2 weeks. The animal is at risk for aspiration pneumonia for its entire life after surgery. The quality of life of the dog is significantly improved in the long term.

**Permanent Tracheostomy**

Permanent tracheostomy is a surgical option for the treatment of dogs with laryngeal paralysis. The permanent tracheostomy bypasses the upper airway obstruction without inducing any modification in the size of the rima glottidis. This surgical technique is therefore more valuable for dogs at high risk of aspiration pneumonia (myopathy, megaesophagus, hiatal hernia, gastrointestinal disorder). Animals responded well to the treatment and owners were satisfied. Permanent tracheostomy requires attention and maintenance from the owners.