The larynx sits at the top of the trachea, where it quite effectively protects the lower airway from aspiration of unwelcome materials. It also modulates airflow during increased exertion, coughing, increased intra-abdominal pressure, and vocalization. Airflow is controlled by active abduction or adduction of the paired arytenoid cartilages dorsally and tensing of the vocal cords ventrally (“sliding doors”). Further fortification against aspiration during swallowing is obtained by passive caudal movement of the hinged epiglottis (“trapdoor”).

**Acquired Laryngeal Paralysis: What has been known forever…**

Acquired laryngeal paralysis has been documented in the literature for almost 40 years, presenting as a common condition in older dogs, particularly the Labrador retriever, but also other purebreds (such as German Shepherds, Golden Retrievers, Australian Shepherds, Borzois, Greyhounds, Newfoundlands, Brittany Spaniels) and mixed breeds. Because a specific cause has not been identified, the term “idiopathic laryngeal paralysis” became the universal descriptor. The condition is insidious in onset, characterized by signs of upper respiratory obstruction (stridor, dyspnea, exercise intolerance) often with severe compromise (hyperthermia, collapse). A changed bark is noted about half the time, and two-thirds of dogs have gagging, throat-clearing, ‘choking’ or coughing, usually associated with eating and drinking. Many dogs will either present as emergencies to the veterinarian, or become emergent upon routine appointment.

The acutely distressed patient will require immediate therapy to alleviate their dyspnea and hypoxia:

- oxygenate (mask, cage, nasal or tracheal insufflation)
- Fluids – be careful, until status of heart, lungs and kidneys are known.
- Sedation. Acetylpromazine (0.05-0.1 mg/kg) -- 0.5 mg IV for most labradors is most commonly used with good effect.
- Cool environment with fan - may need to icepack, alcohol rub etc if severe hyperthermia.
- Corticosteroids (dexamethasone 1mg/kg IV (once), prednisolone 2mg/kg IV – check that dog is not concurrently on NSAID)
- The patient should be observed closely for progression of obstruction. If dog is in complete airway obstruction ---> intravenous barbiturate ---> intubate ---> either temporary tracheostomy, “tie-back” surgery.

Surgical intervention is common, usually in the form of a unilateral crico- or thyro-arytenoid laryngoplasty, which asymmetrically widens the glottis and effectively provides a patent airway. Reported complication rates, however, are high, ranging from 28-56%, with aspiration pneumonia being the most clinically important. Aspiration pneumonia can occur as early as the night of surgery, but can also develop months or even years later. Its appearance has been attributed to the surgical procedure increasing susceptibility to laryngotracheal aspiration, which is a reasonable explanation. Although several different techniques and modifications have been proposed to reduce this complication, thus far we have been unable to prevent or even significantly reduce the incidence of aspiration pneumonia.
New findings in laryngeal paralysis ... and why we call it GOLPP

We had no way to predict which dogs will experience aspiration pneumonia, even months or years later. Once we started questioning owners carefully with a standardized questionnaire, we noted very common concomitant signs of throat-clearing/gagging, so we considered looking at esophageal dysfunction (poor esophageal function is a known risk factor for aspiration pneumonia) in dogs with “idiopathic laryngeal paralysis”.

Upon closer anatomic inspection of cadavers, and an exhaustive review of the literature, we realized that the innervation of the larynx and the cranial esophagus are quite similar. Because we know the nerves to the larynx degenerate, we wondered if the nerves to the cranial esophagus also degenerated. If this were so, laryngeal and esophageal dysfunction may occur concurrently.

We conducted a 2 year, prospective study to compare esophageal function in dogs with “idiopathic laryngeal paralysis” with age- and breed-matched controls, and to see if any esophageal dysfunction could be related to the development of aspiration pneumonia during a one year follow-up. Additionally, a comparison of neurologic status was made every few months over the study period. A total of 66 dogs were enrolled – 32 affected dogs, 34 controls. Each dog underwent 3-phase esophagrams (liquid, canned food, kibble), and was scored by independent, blinded observers. After unilateral cricoarytenoid laryngoplasty, affected dogs were re-examined, including thoracic radiography, at 1, 3, 6, and 12 months. Neurologic examinations repeated at 3, 6, and 12 months.

The three most clinically significant findings of the study were:
1. Esophageal dysfunction in dogs with laryngeal paralysis was significantly worse compared to control dogs, most notably in the liquid phase. Dysfunction was more pronounced in the cranial esophagus.
2. Dogs that experienced aspiration pneumonia in the study period (18%) had significantly worse esophageal dysfunction than those dogs that did not develop aspiration pneumonia.
3. One third of affected dogs had generalized neurologic signs on enrollment, and all dogs had signs of polyneuropathy at study end (12 months).

We concluded that the disorder we have been calling “idiopathic laryngeal paralysis” for many years, is actually a chronic, progressive, polyneuropathy with early manifestations of laryngeal and esophageal dysfunction. These findings have also now been found by others. A more accurate term for the disease may be “geriatric onset laryngeal paralysis polyneuropathy”, or GOLPP. We now have over 140 dogs enrolled into our GOLPP study, where we are looking at improving their esophageal function, performing peripheral nerve and muscle biopsies, EMGs and nerve conduction testing, and storing DNA for genetic investigations.

Current Protocol for GOLPP Dogs:

Complete characterization of this disorder has probably been hampered by the fact that the laryngeal surgery is usually performed in a referral setting, and dogs return to their regular veterinarian for extended follow up. In such cases, subsequent neurologic degeneration and swallowing issues may not have been linked to the laryngeal dysfunction. Additionally, affected dogs are often in marked respiratory distress and attention is focused on the upper airway. Without careful and rigorous neurologic assessment, early neurologic dysfunction may have
been misinterpreted as weakness from hypoxia or orthopedic conditions (which are also common in these dogs).

In an effort to accurately describe the natural history of this condition, the following procedures are now routinely recommended on all GOLPP dogs at MSU VTH:

- **Standardised history questionnaire:** This questionnaire is designed so that all relevant questions will be asked in a standardised manner and responses scored.

- **Neurologic examination; Ophthalmic examination; Orthopedic examination:** It is clear that neurologic issues need to be discerned from orthopedic issues, and a dedicated GOLPP Neurologic Exam form has been developed to record responses to the careful and complete neurologic exam. We have additionally seen some ocular changes in these dogs and are now completing full ophthalmic examinations by one of our veterinary ophthalmologists.

- **Pre-operative standing esophagram:** Evaluation of esophageal function in all phases of swallowing is performed fluoroscopically, in standing positions. We have designed and built an esophageal stanchion, so that dogs can eat naturally. Esophageal function is scored, esophageal transit times recorded, gastro-esophageal reflux scored, and hiatal herniation noted. If a dog has very poor esophageal function, we discuss this finding with the owners in depth, and in consideration of the dog’s respiratory compromise.

- **Laryngoscopy:** Laryngeal function is recorded on induction with a digital video-otoscope with a standard induction protocol, including 1 mg/kg doxapram IV to enhance respiratory excursions when needed.

- **Unilateral cricoarytenoid laryngoplasty:** Standardized left lateral approach is performed with disarticulation of the cricoarytenoid joint, no cricothyroid disarticulation, no interarytenoid band transection, two 0-polypropylene sutures passed around the caudal edge of cricoid and through articular facet of the muscular process of the arytenoid. Sutures are pulled snug, but not overtightened. Abduction is confirmed on extubation and recorded with digital still images.

- **Muscle and nerve biopsies:** At time of laryngeal surgery, the dorsal cricoarytenoid muscle is biopsied. Left sided cranial tibialis muscle and peroneal nerve biopsies are performed in a standardized manner per previously described protocol.

- **Esophageal suctioning:** In all cases, even if esophageal function is normal on esophagram, the esophagus is suctioned immediately following induction, intraoperatively and immediately post-operatively, before recovery.

- **Electrodiagnostics:** Under anesthesia, electromyography is performed in the tongue, palatinus, esophageal, cricoarytenoidus dorsalis, cricothyroideus, superficial digital flexor, extensor carpi radialis, triceps, biceps, gastrocnemius, cranial tibialis, semimembranosus, semitendinosus, and quadriceps femoris muscles. Motor NCS are performed in the right sciatic-tibial and left ulnar nerves. Typical time for electrodiagnostics is currently 45-60 minutes.

- **Management of esophageal dysfunction:** Based on preliminary results from a positional esophagram study just completed, we recommend feeding at a 30 degree incline plane with head up, and maintaining the dog in sitting position for 10 minutes post prandially. We also prescribe metoclopramide in dogs with moderate esophageal dysfunction, and add cisapride in dogs with severe dysfunction. We do not have reliable results for the effects of cisapride, but most owners feel that metoclopramide is helpful when given before feeding and before bedtime.
• **Physical therapy:** Water treadmill physiotherapy is recommended for all dogs post-operatively. The aim is to maintain muscle mass as long as possible in the face of neurogenic atrophy. Home exercise is also encouraged, with daily long, slow walks.

• **Owner education:** We have developed owner handouts and constructed a GOLPP website ([http://cvm.msu.edu/golpp](http://cvm.msu.edu/golpp)) to inform owners of GOLPP dogs on this disease and its progression. Owners are educated to identify early signs of aspiration pneumonia (inappetence, lethargy, fever), as we have good success with treatment when caught early. We have found that these dogs are longtime companions and almost always regarded as much-loved members of their human family. As the condition progresses relentlessly over months to several years, euthanasia is typically requested by owners when their pet becomes non-ambulatory, or experiences repeated episodes of aspiration pneumonia from regurgitation, gagging, and/or dysphagia. Occasionally dogs will go into a cart for several months.

• **Follow up:** It is vital for us to follow affected dogs out for the remainder of their life in order for us to understand the natural history of this disease. We now follow our GOLPP dogs out every 3 months until their demise. It is already clear that most dogs will progress at a fairly steady rate, with euthanasia requested within 2-3 years. However, some dogs will progress at remarkably rapid rate. There is also a small group of dogs in which we have noted a surprisingly slow rate of neurologic deterioration. We encourage owners to participate in our post mortem donor scheme so that we can analyze brain and spinal cord tissues.

In addition to studying the natural history of this disease, we are also collecting pedigrees and blood for DNA extraction from affected dogs. We welcome the participation in many parts of our investigations by ACVS board-certified surgeons and their teams. Eventually we will understand this devastating and frustrating disease, enabling us to diagnose it earlier and manage it better, and maybe even identify a causal gene mutation.

**Recommended Reading**

6. Pierard JAM: Comparative anatomy of the carnivore larynx:- with special reference to the cartilages and muscles of the larynx in the dog. MS: Cornell University, 1963.


