The larynx of dogs and cats has several important functions, including control of airflow to the lower respiratory tract, protection against aspiration of ingesta during deglutition, and phonation. At rest, the rima glottidis provides little resistance to airflow. When supranormal oxygen requirements during stress, excitement, or exercise necessitate greater airflow to the lungs, the normal physiologic response is contraction of the paired cricoarytenoideus dorsalis muscles, which causes abduction of the arytenoid cartilage and vocal folds to increase the size of the glottis. This normal physiologic process is impaired when innervation from the recurrent laryngeal nerves to the cricoarytenoideus dorsalis is abnormal. The resulting laryngeal paralysis leaves only a slitlike opening for airflow, which causes a dramatic increase in airway resistance. Narrowing of the glottis can be made worse by medial collapse of the arytenoids and vocal folds secondary to increased subatmospheric pressure generated during forced inspiration. Swelling and inflammation that result from turbulent airflow and mechanical trauma from dynamic collapse also contribute to airway compromise.

Laryngeal paralysis is a common condition in dogs but is rarely seen in cats. Lesions affecting the recurrent laryngeal nerves at any place along their path can cause laryngeal paralysis. The disease has both congenital and acquired forms. The congenital form has been investigated in several dog breeds and is the result of neurogenic degeneration at various levels of the central and peripheral nervous systems. The acquired form is most often idiopathic but may be secondary to neoplasia, trauma, or iatrogenic damage to the recurrent laryngeal nerve at any stage of its passage through the neck or thorax; it may also occur as part of a more generalized neuromuscular disorder. An association between laryngeal paralysis and hypothyroidism has been postulated but never definitively proven. Laryngeal paralysis in cats is usually idiopathic, but other causes include lymphoma, neuromuscular disorders, and iatrogenic damage during thyroidectomy. A clinical syndrome of upper airway obstruction is the result, with most patients showing slowly progressive clinical signs; however, acute exacerbations, sometimes leading to severe respiratory distress, cyanosis, and collapse, are common. Most dogs have bilateral paralysis by the time of presentation. Although mild cases can be managed medically, many animals will require emergency stabilization and surgical treatment at some point. Aspiration pneumonia is often present at the time of diagnosis and is a common postoperative complication.

**DIAGNOSTIC CRITERIA**

**Historical Information**

**Gender Predisposition**
- **Dogs:** Male dogs are affected approximately three times more often than females.
- **Cats:** No sex predilection.

**Inside this issue:**

1. Laryngeal Paralysis
2. Treating Poor Perfusion Associated with Hypovolemia
Age Predisposition
- Congenital form:
  - Dogs: 6 weeks to 3 years.
  - Cats: Usually younger than 2 years.
- Acquired form:
  - Dogs: Usually older than 6 years (mean: 9.5 years).
  - Cats: Mean of 11 years with a very wide age range (4 months to 11 years).

Breed Predisposition
- Dogs:
  - Congenital form: Bouvier des Flandres, bullterriers, dalmatians, rot-tweilers, and Siberian huskies.
  - Acquired form: Labrador retrievers, golden retrievers, Saint Bernards, and Irish setters.
- Cats: No breed predilection has been found in cats.

Owner Observations
- Signs often progress very slowly over several months or years.
- Owners may notice a change in the character of the bark or meow.
- Owners may notice progressive inspiratory stridor, often accompanied by a decrease in exercise tolerance.
- Episodes of severe respiratory distress leading to cyanosis and syncope may have occurred, especially during times of excitement or hot weather.
- Some animals may have dysphagia, which can result in retching and gagging.

Other Historical Considerations/Predispositions
Other historical complaints may be caused by manifestations of trauma or underlying disease (e.g., neoplasia within the neck or thoracic cavity, generalized peripheral neuropathies or myopathies, endocrinopathies such as hypothyroidism).

Physical Examination Findings
- Inspiratory stridor and/or stertorous (snoring) noise is detected but is not always present at rest.
- Crackles may be heard on thoracic auscultation if aspiration pneumonia or noncardiogenic pulmonary edema is present. Lung sounds may be obscured by referred upper airway sound. Auscultation over the larynx will often detect the earliest signs of inspiratory stridor.
- Hyperthermia (common in patients with respiratory distress).
- Signs of polyneuropathy or polymyopathy (e.g., muscle atrophy) may be present in other areas.
- Sometimes the physical examination will be normal.

KEY TO COSTS
$ indicates relative costs of any diagnostic and treatment regimens listed.
$ costs under $250
$$ costs between $250 and $500
$$$ costs between $500 and $1,000
$$$$ costs over $1,000
Laboratory Findings

- Complete blood count, biochemistry panel, and urinalysis are usually normal.
- Preoperative blood gas analysis may reveal evidence of hypoxemia (arterial partial pressure of oxygen <100 mm Hg) and inadequate ventilation (arterial partial pressure of carbon dioxide >45 mm Hg) resulting in respiratory acidosis (pH <7.36).
- If aspiration pneumonia is present, the complete blood count may demonstrate a leukocytosis with or without a left shift.
- If concurrent hypothyroidism is present, hypercholesterolemia, hyperlipidemia, and increased liver enzymes may be present. If so, a thyroid panel is recommended before surgery.

Other Diagnostic Findings

- **Laryngoscopy:** Direct visualization of the arytenoid cartilage under light anesthesia is the most reliable diagnostic test for laryngeal paralysis. The plane of anesthesia should be slowly deepened with incremental doses of a short-acting barbiturate or propofol until the mouth can be held open without resistance. As the examiner observes the larynx, an assistant should announce when the inspiratory phase of respiration occurs. On inspiration, the observer should see clear abduction of the arytenoid cartilage and vocal folds. In dogs with unilateral or bilateral laryngeal paralysis, no movement is seen in one or both arytenoids. The larynx should be observed until the patient can swallow; at deeper planes of anesthesia, a false-positive diagnosis might be made based on excessive muscle relaxation. Medial movement of the arytenoids and vocal folds during inspiration is sometimes observed (paradoxic laryngeal movement) and often completely obscures the rima glottidis. A complete oral and laryngeal examination should be performed at the same time to rule out other inflammatory or neoplastic lesions as well as foreign bodies.
- **Ultrasoundography:** Recent studies have shown good correlation between echolaryngography and laryngoscopy in dogs. Ultrasound examination can be performed rapidly on unsedated patients. The criterion for diagnosis is imaging of asymmetric or nonmotile arytenoids, cartilages, and vocal folds. Experience is likely needed to yield reliable results.
- **Thoracic radiography:** Right and left lateral views and a ventrodorsal view of the thorax should be obtained. Extreme care should be taken if the animal is severely dyspneic because positioning can exacerbate respiratory distress. Evidence of aspiration pneumonia manifests as an alveolar pattern located in the ventral lung fields; the right middle lung lobe is most commonly affected. Noncardio-venous pulmonary edema secondary to an episode of acute upper airway obstruction usually has a caudodorsal distribution. Neoplastic lesions (primary or metastatic)—especially cranial mediastinal masses, which can be the cause of laryngeal paralysis—should be ruled out.
- **Laryngeal and cervical radiography:** Lateral and ventrodorsal views of these areas should ideally be obtained with the animal under general anesthesia. However, if the patient has severe dyspnea, radiography of these areas should be performed with extreme caution—if at all—because results are unremarkable in many cases. Radiographs are examined for evidence of soft tissue masses within or adjacent to airways and for conditions of the soft palate, hyoid apparatus, and trachea. Megaesophagus may be present, possibly as a result of a concurrent polyneuropathy or polymyopathy; it may also be seen in dyspneic dogs.
- **Advanced laryngeal imaging:** Thorough examination of the cervical area using either computed tomography or magnetic resonance imaging may be necessary if lesions are detected by palpation or plain radiography.
- **Electromyography:** Electromyographic examination of the cricoarytenoideus dorsalis can demonstrate denervation, which confirms a diagnosis of laryngeal paralysis.
- **Histopathologic examination of the cricoarytenoideus dorsalis muscle:** This can allow postoperative demonstration of neurogenic atrophy but does not provide a noninvasive presurgical diagnosis.
- **Transtracheal wash:** This adjunctive test is used to confirm diagnosis and clarify the cause of aspiration pneumonia. A sterile suction catheter is passed through the lumen of a sterile endotracheal tube and used to aspirate a sample of fluid after instillation of 1 to 3 ml/kg of a sterile 0.9% NaCl solution (usually only 20% to 30% of the instilled solution is recovered). The use of a sterile suction trap allows collection of an uncontaminated fluid sample, which should be submitted for culture and sensitivity testing to guide antibiotic selection.

Summary of Diagnostic Criteria

- Laryngoscopy under a light plane of anesthesia is the most useful test to diagnose laryngeal paralysis.
- Laryngeal paralysis is strongly suspected in older, large-breed dogs that present with a history of progressively worsening inspiratory stridor, exercise intolerance, and respiratory distress.
- Adjunctive diagnostics (e.g., complete blood count, biochemical panel, urinalysis, thoracic radiography) to identify related disorders or underlying causes are strongly advised.
• Because severely affected dogs have difficulty recovering from anesthesia, it is beneficial to have owners available or their preapproval for surgical correction.

Diagnostic Differentials
• Laryngeal or tracheal neoplasia: Lesions can often be seen and biopsy samples collected during laryngoscopy. Care should be taken during visualization and biopsy because laryngeal neoplasia can often be very advanced at presentation; near-total occlusion of the airway is common. Radiographs of the laryngeal area and proximal trachea may show soft tissue masses.
• Laryngeal or tracheal foreign body: Uncommon; can usually be ruled out by radiography, laryngoscopy, and/or bronchoscopy.
• Laryngeal trauma: Rare but may be associated with severe clinical signs. Diagnosis may be made based on laryngoscopy and laryngeal radiography.
• Laryngitis: Can be secondary to infectious diseases (e.g., kennel cough in dogs; feline herpesvirus and calicivirus infections in cats), which are usually diagnosed based on history, clinical signs, and sometimes culture of causative organisms.
• Pharyngeal salivary mucocele: Uncommon; the location can cause upper airway obstruction.
• Laryngeal webbing: Can occur as a postoperative problem in animals that have previously undergone partial laryngectomy.
• Laryngeal or pharyngeal congenital cysts: Few reports identify congenital cystic structures as a possible cause of upper airway obstruction.
• Rabies: Rare, but its zoonotic potential makes rabies an important differential diagnosis.

TREATMENT RECOMMENDATIONS

Although many patients are stable on presentation, various degrees of respiratory distress can necessitate emergency management before definitive surgical repair can be considered.

Emergency Management
• Rest in an oxygen-enriched environment: Animals should not be handled excessively, stress should be minimized, and oxygen supplementation should be provided. An oxygen cage is the least stressful environment, but nasal prongs are a good alternative if a cage is not available. With large-breed dogs, oxygen cages must have an air-cooling function; otherwise, hyperthermia and respiratory distress may be exacerbated.
• Sedation: Many animals will benefit from sedatives. Acepromazine (0.05–0.1 mg/kg IV) is the drug of choice and can decrease normal laryngeal movement during laryngoscopy. It may be more effective when combined with an opioid analgesic such as butorphanol (0.2–0.4 mg/kg IV) or hydromorphone (0.05–0.1 mg/kg IV). Care should be used when administering these drugs, especially in hypovolemic patients. Some centrally acting opioids can induce dysphoria, which can exacerbate clinical signs.
• Vascular access: Intravenous access should be established as soon as possible.
• Temperature monitoring: Hyperthermia is common in patients in respiratory distress. Core temperature should be closely monitored. Cooling water showers, fans, administration of cool intravenous fluids, or application of alcohol to the extremities should be considered if the patient's temperature exceeds 104°F.
• Corticosteroid administration: The antiinflammatory effects of corticosteroids (dexamethasone: 0.25–0.5 mg/kg IV once or q8h if necessary) can be very helpful in decreasing laryngeal edema and inflammation secondary to turbulent airflow and laryngeal collapse. If lymphosarcoma or other neoplastic processes are highly suspected, corticosteroids should be used with caution because they can adversely affect subsequent diagnosis and management of these conditions.
• Fluid therapy: Isotonic saline solution should be administered to hypovolemic or dehydrated animals. Care should be taken to avoid fluid overload in patients with preexisting aspiration pneumonia or noncardiogenic pulmonary edema.
• Endotracheal intubation and/or temporary tracheostomy placement: When respiratory distress is severe on presentation, immediate endotracheal intubation may be lifesaving. Sedation is usually required. An endotracheal tube can exacerbate laryngeal inflammation and edema and thus should not be allowed to remain in place for more than a few hours. When the patient has been stabilized, the endotracheal tube should be removed; if severe stridor or respiratory difficulty persists, placement of a temporary tracheostomy tube should be considered (see box on page 5).

Medical Management
Patients with few clinical signs (e.g., mild stridor with no respiratory distress) can be managed medically. Avoidance of stress, excitement, and exposure to hot environments is important. Weight loss in obese patients can help to decrease perilaryngeal soft tissue
obstruction, although this can be difficult to achieve when rest needs to be enforced. Failure is often the result of owner noncompliance and disease progression. Many dogs will eventually require surgery.

**Surgical Management $$$$**

Patients presenting in moderate to severe respiratory distress are candidates for surgery. Preoperative stabilization should be pursued as described previously. Surgery should be delayed until preexisting aspiration pneumonia or noncardiogenic pulmonary edema has been resolved. Complications of laryngeal surgery are common and should be discussed with owners (see box on page 6). The three most common surgical procedures for the treatment of laryngeal paralysis in dogs are outlined here.

**Arytenoid Lateralization**

Arytenoid lateralization is the most widely practiced procedure for uncomplicated management of laryngeal paralysis in dogs and cats. It is usually performed unilaterally; bilateral lateralization creates a wide glottic diameter and predisposes to aspiration pneumonia. A lateral approach to the larynx is made ventral to the jugular groove. The sternothyroides muscle is retracted ventrally to expose the thyropharyngeus muscle, which is transected at the level of the dorsal edge of the thyroid cartilage.

After the wing of the thyroid cartilage is retracted, the cricothyroid articulation is transected. At this point, the muscular process of the arytenoid cartilage can be palpated and the cricoarytenoideus dorsalis muscle visualized and transected; some muscle should remain attached so that retraction of the muscular process can be achieved without handling the calcified cartilage of the muscular process, which is sometimes brittle. Delicate dissection of the joint capsule and soft tissue around the cricoarytenoid articulation allows caudal retraction of the muscular process.

Once relatively free movement has been achieved, sutures can be placed. One or more 2-0 nonabsorbable simple interrupted or horizontal mattress sutures are placed between the caudodorsal aspect of the cricoid cartilage and the arytenoid and are then tied. In cats, small (4-0) sutures should be mounted on pledgets to prevent suture pull-through. Excessive needle passages or tension on the suture material is unnecessary and may predispose to fragmentation of the muscular process or suture breakage. Closure involves apposition of the thyropharyngeus muscle followed by routine closure of the subcutaneous tissue and skin. Intra- or postoperative laryngoscopic examination should confirm adequate abduction of the arytenoid cartilage on the operated side. Unilateral arytenoid lateralization has been associated with an 8% mortality rate within 1 month of surgery. Mortality within 3 years after surgery is 30%.

**Partial Laryngectomy**

Partial laryngectomy can be performed via an oral approach or, in small dogs, via a ventral approach. A
temporary tracheostomy should be performed before the procedure. Complete unilateral excision of the vocal fold and the corniculate and vocal processes of the arytenoid should be achieved. This procedure has been associated with a 50% complication rate. The most common complication is webbing or scar tissue formation, which reduces the diameter of the rima glottidis over time. Prednisone (0.25–1 mg/kg PO for the first 3 days followed by a tapering dose over the next 2 weeks) can be administered perioperatively to minimize scar formation. Partial laryngectomy has been associated with a 20% mortality rate within 1 month of surgery. Mortality within 1 year after surgery was 30% in one study.

Permanent Tracheostomy
Permanent tracheostomy is a salvage procedure that allows a patient’s normal upper airway to be bypassed. It is indicated in patients in which traditional surgical procedures aimed at opening the normal rima glottidis failed. It can be well tolerated but requires careful owner compliance to prevent activities (e.g., swimming) that may allow aspiration of foreign material through the tracheal stoma.

Supportive Treatment
• Avoidance of stress and vigorous exercise.
• Provision of a cool environmental temperature at all times.
• Consideration of a weight-loss program in overweight animals.
• Supportive treatment of any underlying or concurrent diseases.

Patient Monitoring
• After surgery, patients are maintained on intravenous fluids for 24 to 48 hours. Small moist meatballs are fed initially the day after surgery; the patient should be closely observed for any aspiration. If food is tolerated, small quantities of water can be reintroduced with continued careful monitoring.
• Sutures can be removed 2 weeks after surgery; respiratory function should be reevaluated at this time.
• Complete exercise restriction should be enforced for 6 weeks after surgery.
• Follow-up thoracic radiography is recommended in patients with aspiration pneumonia until signs resolve, as well as during any subsequent bouts of deteriorating respiratory function.

Home Management
• Owners should continue to avoid subjecting their pet to any stressful environment after surgery. These dogs will never have normal laryngeal function and can experience respiratory crises if stressed.
• Weight loss regimens should be instituted for overweight patients.
• Patients should be fed soft, moist diets; overly dry or liquid diets, which may promote aspiration pneumonia, should be avoided. Owners should be counseled that patients remain predisposed to aspiration pneumonia for life after surgery, regardless of the procedure used.
• Patients should wear harnesses rather than neck leashes when being walked for the rest of their lives.
Owners should be vigilant in detecting any deterioration in respiratory function (e.g., dyspnea, coughing), which may indicate an episode of aspiration pneumonia.

Milestones/Recovery Time Frames

- Some retching or gagging is to be expected in the postoperative period, especially in conjunction with eating or drinking, but should improve within 1 to 2 weeks.
- Complete resolution of stridulous breathing is not seen in all patients because surgery usually does not restore normal glottic diameter. The goal of surgery is to widen the glottis enough to allow adequate airflow but not so much as to allow aspiration.
- After 6 weeks of postoperative rest, exercise tolerance should be improved and stridor should be significantly diminished.

Treatment Contraindications

- Corticosteroids should be used with caution in any animal with aspiration pneumonia.
- Stress or exercise can induce episodes of dyspnea, cyanosis, collapse, and death.
- Aggressive fluid therapy should be avoided in animals with noncardiogenic pulmonary edema or aspiration pneumonia.
- Simultaneous bilateral arytenoid lateralization is not recommended. It causes a very wide rima glottidis and thus may be more likely to predispose patients to aspiration pneumonia than other procedures would. It has been associated with 75% mortality within 1 month of surgery.

PROGNOSIS

Favorable Criteria

- Dogs younger than 12 years.
- No concurrent disease, especially aspiration pneumonia or megaesophagus.
- Patient not in acute respiratory distress.
- No postoperative complications.

Unfavorable Criteria

- Dogs older than 12 years.
- Concurrent respiratory tract abnormalities or esophageal disease.
- Concurrent neoplastic or neurologic disease.
- Postoperative megaesophagus.
- Temporary tracheostomy placement.

RECOMMENDED READING


