LARYNGEAL PARALYSIS: Treatment Choices and Expected Outcome

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Objectives:

• To review the causes and the progression of laryngeal paralysis
• To review diagnostic recommendations
• To describe treatment options
• To describe expected outcome

Overview

Laryngeal paralysis causes laryngeal obstruction. It is a congenital or acquired failure of the arytenoid cartilages and vocal folds to abduct. Normal abduction fails when there is degeneration or disruption of the vagus or recurrent laryngeal nerves which provide intrinsic muscular innervation to the larynx. The larynx may be affected unilaterally or bilaterally causing varying degrees of respiratory distress. Small, inactive animals often have minimal signs of respiratory distress and require no treatment. Others may be totally exercise intolerant being cyanotic at rest or with minimal movement. All animals with laryngeal paralysis are at risk for aspiration of food and saliva because of laryngeal dysfunction and esophageal motility disorders. Subsequent aspiration pneumonia is a risk and may be fatal. Diagnostics include a complete physical examination which includes a neurologic examination, cervical and thoracic imaging, respiratory endoscopy, electrodiagnostic testing, esophagram, testing for myasthenia gravis, endocrine and metabolic diseases, and muscle and nerve biopsy examinations. Small and mildly affected animals may be treated medically to control symptoms and improve the quality of life. Many surgical techniques have been suggested to alleviate moderate to severe signs of laryngeal paralysis. The goal of treatment is to enlarge the size of the glottis without exaggerating laryngeal aspiration of food and saliva.

Most surgical techniques used clinically to treat laryngeal paralysis may be grouped into partial laryngectomy techniques or lateralization techniques. Lateralization procedures include various "arytenoid tie-back" procedures which will be referred to as suture lateralization procedures and
castellation procedures or "stepped laryngofissures" which will be referred to as castellation procedures. Partial laryngectomy procedures may include partial resection of the corniculate process of the arytenoid, and / or partial or complete resection of the vocal folds and aryepiglottic folds. Other described techniques include muscle-nerve pedicle transposition and arytenoid stenting. A muscle-nerve pedicle transposition has also been investigated but there are no clinical reports to support the use of this technique in patients with laryngeal paralysis. A study by Cabano describing laryngeal stenting in cadavers showed this technique adequately reduced open-epiglottic airway resistance enough to alleviate clinical signs while increasing closed-epiglottic resistance enough to decrease the risk of postoperative aspiration pneumonia.

**Surgical Techniques**

*Partial laryngectomy*

Partial laryngectomy techniques may be performed unilaterally or bilaterally. These procedures are performed using an oral or laryngotomy approach. In general, oral procedures should be limited to one side of the larynx during each surgical episode to minimize the risk of postoperative obstructive inflammation and laryngeal (glottic) stenosis. The incidence of postoperative laryngeal stenosis or webbing is also reduced by leaving the epithelium of the dorsal and ventral commissures of the larynx intact. Laryngotomy procedures allow more complete resection of the vocal folds and may be performed bilaterally but should include apposition of mucosa at resection sites to minimize stenosis. Perioperative steroids are given to minimize postoperative respiratory distress secondary to inflammation and edema. Tube tracheostomies may be beneficial as orally placed endotracheal tubes often interfere with the surgical procedure. Postoperatively the tracheostomy tube provides an alternate route for airflow should edema obstruct the larynx.

Complete vocal fold excision (ventriculocordectomy) as a sole method of enlarging the glottis has not been thoroughly investigated. However, the results have been good in a few cases and the technique may be useful in patients with minimal to moderate respiratory distress. Holt and Harvey reported 87% satisfactory results (n = 30/40) following bilateral ventriculocordectomy via an oral approach. Unsatisfactory results were due to glottic stenosis and pneumonia. Removal of the vocal folds enlarges the ventral aspect of the glottis. Resection is accomplished
with scissors, biopsy forceps, electrosurgery or surgical lasers. The advantage of the oral approach is that it is less invasive; disadvantages include difficulty in completely resecting the vocal folds and inability to close the mucosa. The advantages of laryngotomy are that exposure and access to the vocal folds is better and mucosal closure is easier. Disadvantages of laryngotomy include it being a more invasive procedure, having a higher incidence of laryngeal webbing (glottic stenosis) if the mucosa is not closed at resection sites, and usually requiring temporary tracheostomy.

Aryepiglottic fold resection may be indicated if animals concurrently have stage two laryngeal collapse (medial deviation of the aryepiglottic folds). Collapse of the aryepiglottic folds obstructs the ventral aspect of the glottis. Removal of one or both of these folds is believed to allow less restricted airflow into the ventral aspect of the glottis. Allen and Caywood reported 87% satisfactory results (n=13/15) following bilateral ventriculocordectomy and unilateral resection of the cuneiform process via an oral approach. Unsatisfactory results (2/15) were due to laryngeal collapse and glottic stenosis.

Partial resection of one or both corniculate processes enlarges the dorsal aspect of the glottis. The procedure is usually performed using an oral approach. During laryngoscopy the functional size of the airway cannot be easily assessed. The amount of tissue to remove is subjective and difficult to determine because it is inflamed and edematous. The goal is to enlarge the glottis so its size approaches that expected at maximal abduction during light anesthesia in a patient of similar size. It is important to keep the dorsolateral rim of the corniculate process intact and supported to allow sealing of the glottis when it is covered by the epiglottis during swallowing. Recently a video-assisted unilateral arytenoidectomy using a diode laser photoablation technique has been described (Olivieri). Following photoablation dogs were treated with prednisone for 7 days.

**Outcome:** Results from a cadaver study reported by Harvey indicated the glottic size can be increased in size by approximately 85% following bilateral vocal fold resection and unilateral partial corniculate process resection. Clinical impressions and reported results following partial laryngectomy procedures in laryngeal paralysis patients are complicated by aspiration, stenosis
and persistent clinical signs. Most surgeons have abandoned these procedures as a means of treating laryngeal paralysis. In a clinical study by Harvey the immediate death rate following partial laryngectomy was 15% (6/39), and long-term death due to airway disease occurred in 36% (12) of the patients. Ross reported a similar series involving 45 patients with 45% dead or euthanized due to airway obstruction and 18% requiring a second surgery. Following photoablation there were no immediate complications and no evidence of stricture formation on endoscopic re-evaluation at 6 months however aspiration pneumonia occurred in 10% (Olieri). Very experienced individuals can have satisfactory results with partial arytenoidectomy (Trout).

Recently outcome after bilateral ventriculocordectomy has been reported with high owner satisfaction (86%-93%). Despite owner satisfaction there was a high complication rate (52%) in one study (Bahr) where bilateral ventriculocordectomy was performed using an oral approach in 25 dogs. Chronic respiratory distress occurred in 36% and 16% had aspiration pneumonia with 24% requiring revision surgery (Bahr). In another study involving 88 dogs (Zikes) bilateral ventriculocordectomy was performed using a laryngotomy approach with results judged by owners as giving very satisfactory (resolved respiratory distress and minimal respiration abnormalities) in 93% and unsatisfactory (scaring or fatal pneumonia) in 7%. In this study major complications were considered those requiring surgical intervention or hospitalization, these occurred in 3.4% during the first 14 days and 7.1% more than 6 months after surgery (Zikes).

**Lateralization Procedures**

Castellation was originally described as including a stepped incision and realignment of the thyroid cartilage with vocal fold resection via a laryngotomy. It was later modified by adding bilateral arytenoid lateralization via horizontal mattress sutures placed through the thyroid cartilage and body of the arytenoid cartilage dorsal to the vocal process. Both castellation procedures require tracheostomy tube maintenance for 1-6 days. Following modified castellated laryngofissure procedures results of tidal breathing flow volume loop evaluations were normal in 7/10 patients and clinical signs of upper respiratory obstruction disappeared or decreased in severity in all 11 dogs who survived surgery. One dog did not survive surgery. Castellation procedures are technically more difficult, time consuming and traumatic than are suture lateralization procedures.
Many slightly different suture lateralization or "tie-back" procedures have been described. The goal is to have an optimal rima glottis area to relieve signs of respiratory distress while minimizing the loss of epiglottic seal with the arytenoid cartilages during swallowing. Most techniques differ only in the degree of disarticulation of the laryngeal cartilages and the placement of the suture(s). Some surgeons recommend no disarticulation, others recommend disarticulation of the cricothyroid, cricoarytenoid, and/or interarytenoid junctions.

Disarticulation of the cricothyroid and cricoarytenoid joints improves visualization and facilitates suture placement. It has been speculated that disarticulation of these joints may lead to loss of support and subsequently partial collapse or distortion of the larynx, although this has not been documented clinically. Transecting the sesamoid band or interarytenoid ligament allows lateralization of one arytenoid without pulling the other arytenoid to that side. The danger of severing this ligament is that the laryngeal mucosa may be penetrated during the procedure. Some (Weinstein) recommend intraoperative extubation to allow evaluate intraoperative abduction prior to tying the abduction suture. This allows additional dissection if necessary to achieve the desired degree of abduction and allows suture adjustment which may prevent complications.

Suture placement may be through the muscular process of the arytenoid to the caudodorsal aspect of the cricoid cartilage or the thyroid cartilage. Placing sutures through the arcuate crest of the muscular process avoids suture pull out. Some authors recommend placing two sutures both directed through the same cartilage or with one going to the thyroid and the other to the cricoid cartilage. Placement of multiple sutures in the muscular process may weaken the process and lead to suture failure. Muscular process-to-thyroid sutures tend to pull the arytenoid laterally while muscular process-to-cricoid sutures tend to rotate the arytenoid laterally. The surgeon or assistant should visualize the arytenoid as lateralizing sutures are tied to insure moderate abduction (low tension). If abduction is not judged to be sufficient more complete dissection can be performed or the suture can be repositioned to achieve better abduction. Avoid maximal abduction as this increases risks of aspiration. In young, congenitally affected animals cartilages may be insufficiently mineralized to satisfactorily retain suture. In some older dogs with
extensive mineralization of the cartilages introduction of the suture is difficult and is facilitate by disarticulation.

Studies evaluating some variations in lateralization techniques have been investigated and the following reported. In a cadaver study by Harvey, unilateral suture lateralization (cricoarytenoid disarticulation, suture to thyroid cartilage) resulted in a 70% increase in glottic size, while bilateral lateralization resulted in a 182% increase in glottic size. However, bilateral lateralization is not recommended as clinically these animals have a much higher incidence of postoperative aspiration. Other studies by Lozier, Lussier and Griffith reported greater glottic area increases using the cricoid technique (82-207%) rather than the thyroid technique (70-140%). Bureau showed that low tension rather than high tension when tying the suture would be expected to provide more epiglottic protection of the glottis. Guillemot showed that disarticulation of the cricoarytenoid joint led to a 42% increase in lack of laryngeal epiglottic-glottic seal after unilateral cricoarytenoid lateralization in cadavers. Likewise cricothyroid disarticulation lead to an 11% increase and transection of the interarytenoid ligament (sesamoid band) a 150% increase in the gap between the epiglottis and corniculate when the glottis is closed (Guillemot). Greenburg showed that low tension sutures are expected to reduce laryngeal resistance enough to alleviate clinical signs while maintaining enough closed-epiglottis laryngeal resistance to reduce the risk of postoperative aspiration pneumonia. Gauthier’s cadaver study reported that the suture through the cricoid cartilage should penetrate laterally just caudal to the cricoarytenoid articulation to sufficiently reduce airway resistance without increasing the risk of pneumonia. Contrary to this Guillemot concluded that optimal rima glottis area is associated with minimal loss of rima glottis-epiglottis seal when there is dorsal placement of the cricoarytenoid suture when leaving the cricothyroid joint and interarytenoid ligament intact. In another cadaver study measuring airway pressure rather than resistance Wignall concluded that cricoarytenoid lateralization and cricothyroarytenoid lateralization lead to lower airway pressure than thyroarytenoid lateralization and that division of the interarytenoid band or disarticulation of the cricothyroid joint had little effect on pressure. A less invasive approach to the larynx which preserved more thyropharyngeus and the cricopharyngeus muscle and neurovascular anatomy is advocated by von Pfeil to reduce the risk of aspiration pneumonia.
**Outcome:** Unilateral suture lateralization was reported by Lane to be 97% (162/167) successful and by White to be more than 90% successful. Using von Pfeil’s technique owners report 95.5% improved respiration and 90% improved exercise tolerance. Reported complications rates vary greatly 10% (White; Demetrou) to 60% (Bahr) following unilateral lateralization. A study by Hammel involving 39 dogs with unilateral lateralization reported 90% had improved quality of life with 56% of cases experiencing minor complications and 18% of cases with pneumonia of which only one required treatment. A study by McPhail reported follow-up on 126 dogs treated with unilateral lateralization, bilateral lateralization and partial laryngectomy. Overall the complication rate was 38% with aspiration pneumonia accounting for most of the complications. The complication rate in those who had unilateral lateralization 28.4% (31/109), bilateral lateralization was 89% (8/9), partial laryngectomy 40% (6/20). Bahr reported 60% complication rate in 20 dogs following unilateral arytenoid lateralization with most associated with aspiration pneumonia (45%) or acute respiratory distress (20%). Using the less invasive surgery approach in 22 dogs described by von Pfeil there was a 9% death rate associated with aspiration pneumonia, 9% recovering from aspiration pneumonia and 4.5% requiring surgery on the opposite side due to collapse. Prosthesis failure occurs in about 5%. Greater risk of complications occurs with older age, temporary tracheostomy, concurrent respiratory abnormalities, concurrent esophageal, neoplastic or neurologic disease (3.28 x greater risk death), and those who developed postoperative megaesophagus (McPhail).

Early complications of suture lateralization procedures can include hematoma or seroma formation, suture avulsion, deglutition discomfort, temporary glottic impairment, and coughing or gagging after eating or drinking. These problems usually resolve within a few days, except perhaps coughing if aspiration continues. Loss of voice and hoarseness may also occur. Continued respiratory distress is seen with inflammation, swelling, laryngeal collapse or technique failure. Aspiration pneumonia may occur at any time before or after surgery because of esophageal motility disorders, failure of arytenoids to adduct normally and incomplete epiglottic closure or failure to form a seal with the corniculate cartilages.

Unilateral lateralization of the arytenoids to either the cricoid or thyroid cartilage using moderate abduction (low tension) is the recommended surgical technique. The majority of animals will
make less noise, have increased exercise tolerance with more rapid recovery, and cough less postoperatively. However, neurologic deterioration consistent with a generalized polyneuropathy is expected within the first year (Stanley, Thieman)

**Summary**

Is surgery a good idea for animals with laryngeal paralysis? Yes, provided they are symptomatic having moderate to severe dyspnea and a surgical technique is selected that generally results in improved quality of life without major complications. Unilateral arytenoid lateralization with moderate abduction is currently the preferred surgical technique. Whether surgery is performed or not animals with laryngeal paralysis are at risk for aspiration pneumonia and progression of neurologic signs.

**Key Points:**

- Laryngeal paralysis in dogs and cats is usually bilateral and often associated with a polyneuropathy.
- The majority of cases presented for treatment are in large breed dogs, especially Labrador retrievers.
- All laryngeal paralysis cases are at risk for aspiration pneumonia.

**Diagnosis:**

- Thoracic radiographs allow evaluation for pneumonia; cervical radiographs identify mineralization and may help rule-out laryngeal masses.
- Laryngoscopy under a light plane of anesthesia confirms lack of abduction, use of dopram may be beneficial.
- EMG studies may identify abnormalities.
- Esophagrams may identify concurrent esophageal dysfunction.
- Testing for myasthenia gravis, hypothyroidism, Cushings disease, and other endocrine and metabolic diseases may identify and etiology.
- Muscle and nerve biopsy with histopathologic evaluation may identify generalized polyneuropathy or myopathy.

**Therapeutics:**

- Unilateral arytenoid lateralization with moderate abduction is recommended.
- Modify exercise as needed.
- Treat aspiration pneumonia when necessary.
- Monitor for progression of neurologic disease.

**Prognosis:**
- Most improve following lateralization
- Complications range from 10-58% with aspiration pneumonia being one of the most important.
- Dogs with “idiopathic” laryngeal paralysis frequently show signs of a generalized polyneuropathy within one year.

**References**


