

# SURGERY OF THE EQUINE UPPER RESPIRATORY TRACT: FOCUS ON DYNAMIC DISORDERS

Britta Leise, DVM, PhD, DACVS

Assistant Professor, Equine Surgery and Lameness

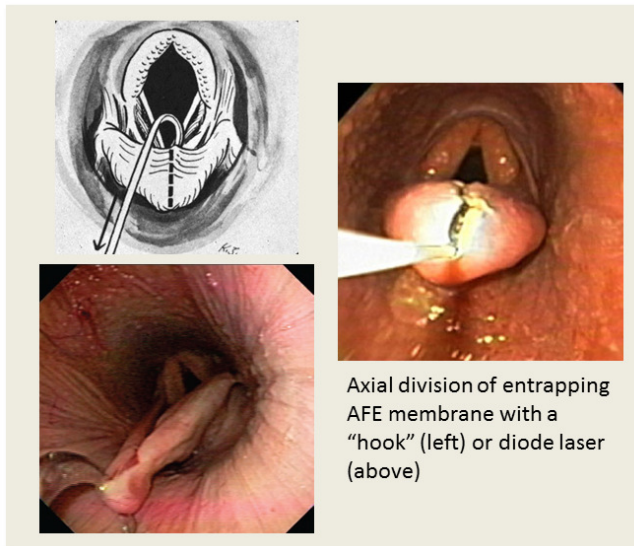
Colorado State University College of Veterinary and Biomedical Sciences

Dynamic conditions of the upper respiratory tract in the horse are being increasingly diagnosed across multiple disciplines with the improved diagnostic abilities in over ground endoscopy. Numerous conditions including palatal malfunction, pharyngeal wall collapse, vocal cord collapse, axial deviation of the aryepiglottic folds, intermittent epiglottic entrapment, and arytenoid dysfunction have been described as primarily dynamic conditions.<sup>1</sup> Other conditions such as laryngeal hemiplegia can be diagnosed with resting endoscopy, but its affect on airway patency can be variable dynamically. Today's presentation will follow the previous discussion by Dr. Hackett on dynamic endoscopy and is meant to be review of surgical treatment of these dynamic conditions, particularly focusing on treatment options, post operative management, complications and outcomes.

## Epiglottic entrapment (EE):

Epiglottic entrapment is the most common epiglottic abnormality and occurs when the epiglottis is entrapped by the aryepiglottic fold. Although most cases are persistently entrapped, intermittent entrapment can occur during exercise. Proposed etiologies include loss of an airtight seal between the epiglottis and the soft palate (such as cases with palatal defects or subepiglottic cyst), presence of a hypoplastic or flaccid epiglottis and the presence of high inspiratory pressures (such as with laryngeal hemiplegia. Clinical signs reported in horses with EE are abnormal respiratory noise on exhalation, exercise intolerance, coughing at rest and mild intermittent nasal discharge.

Although medical management with topical and systemic anti-inflammatories can be used, surgical treatment is usually recommended. The most common surgical therapy is axial division of the entrapping aryepiglottic membrane. The approach can be either transoral or transnasal. Transoral is quickly performed under IV anesthesia by displacing the soft palate and diving the entrapping membrane over the epiglottis with a long curved bistoury knife. Transnasal resection has been described by either using a guarded "hook"knife or via transendoscopic laser under standing sedation. Injection of the epiglottis with a Teflon paste to augment and stiffen the epiglottis may be beneficial in cases with epiglottic hypoplasia. In horses with more complicated cases, such as those with thickened, ulcerative or fibrotic entrapping membranes, resection of the membrane via a laryngotomy is often indicated for a more complete resection and further evaluation of the epiglottis. Post operative management includes rest, non-steroidal anti-inflammatories. In uncomplicated cases, horses can typically return to work in 3 to 4 weeks. Those with more complicated cases may require



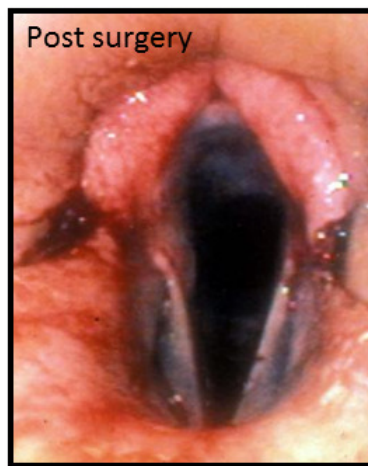
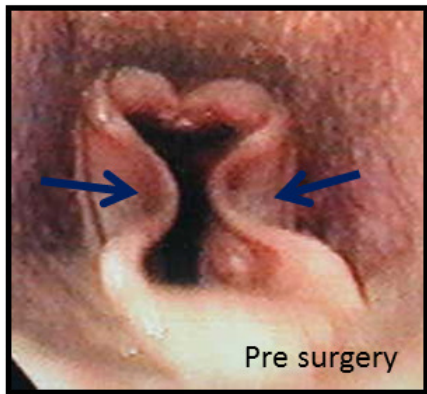
Axial division of entrapping AFE membrane with a "hook" (left) or diode laser (above)

longer rest and more aggressive anti-inflammatory therapy. Complications associated with treatment include iatrogenic damage to the epiglottis, pharynx or soft palate with hook or laser, thermal damage to the epiglottic cartilage, dorsal displacement of the soft palate (more common in complicated cases with excessive fibrosis or ulceration), and re-entrapment.

Prognosis is good with a reported 80-90% success. Reported recurrence rates range between 5-15% and DDSP occurrence post surgery has been reported to be 10%. Prognosis has been reported to be decreased in complicated cases requiring resection via laryngotomy with a reported 27% positive outcome in one report. Reasons for decrease prognosis in cases where resection of the entrapped membrane has been performed via laryngotomy are from the necessary removal of an increased amount of the affected aryepiglottic membrane resulting in an inappropriate interpharyngeal seal and/or from the increased severity of changes within the entrapped membrane and epiglottis.

**Axial deviation of the aryepiglottic folds (ADAF):**

Axial deviation of the aryepiglottic folds (ADAF) is reported to occur in approximately 6% of horses evaluated for poor performance. It is a dynamic condition and can occur with other upper respiratory tract conditions. Dynamic endoscopic findings demonstrate medial displacement of the vertical margins of one or both the aryepiglottic folds during inspiration. Clinical signs are an associated



respiratory noise at work described as an inspiratory whistle and poor performance. King et al (2001) has described 3 grades of ADAF and include (A) mild ADAF where the aryepiglottic fold remains abaxial to the vocal cord (B) moderate ADAF where the aryepiglottic fold collapses less than half way between the vocal

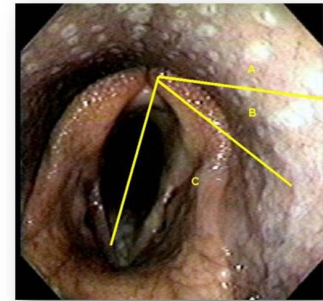
cords and midline and (C) severe ADAF where the aryepiglottic fold collapses greater than half way between vocal cords and midline.<sup>2</sup> Surgical treatment is via transendoscopic laser resection of the aryepiglottic folds. Associated upper respiratory tract conditions should be addressed as indicated. Post-operative management includes rest and anti-inflammatories. Prognosis overall is considered good. Although rest alone had approximately 50% improved performance in horses with ADAF alone, surgery resulted in an improved outcome with up to 75% returning to previous performance.<sup>2</sup>

Laryngeal Grade	Definition
I	Synchronous and full abduction of the arytenoid cartilages
II	Asynchronous movement (hesitation, flutter, abduction weakness, etc.) of the arytenoid cartilage during any phase of respiration. Full abduction is observed either by swallowing, nasal occlusion, or use of respiratory stimulants.
III	Asynchronous movement (hesitation, flutter, abduction weakness, etc.) of the arytenoid cartilage during any phase of respiration. Full abduction can NOT be induced by either swallowing, nasal occlusion, or use of respiratory stimulants
IV	Midline or paramedian position of the arytenoid cartilage and no substantial movement can be induced by swallowing, nasal occlusion, or use of respiratory stimulants

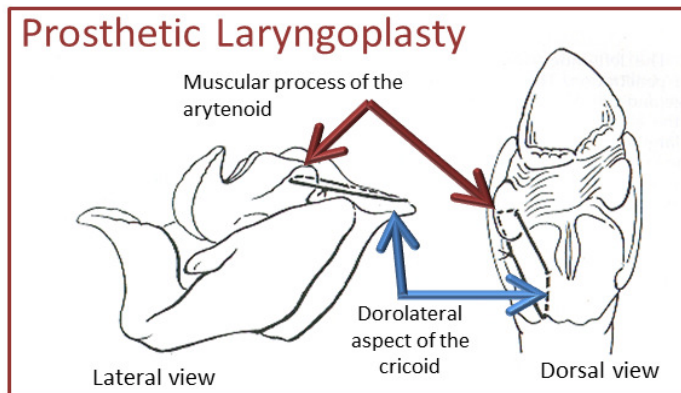
**Laryngeal hemiplegia (LH):**

Laryngeal hemiplegia (LH) is the most common cause of upper respiratory tract unsoundness in the horse. Reported prevalence varies with breed with 7% being reported in thoroughbreds and up to 35% in competition draft horses. Age of onset is also variable and breed dependent with thoroughbreds typically presenting at 2 to 3 years of age and draft breeds between 4 and 8 years of age. The most common cause of left sided LH is idiopathic resulting from progressive loss of large myelinated axons of recurrent laryngeal nerve and subsequent neurogenic atrophy of the cricoarytenoideus dorsalis muscle. Other causes of LH are head/neck trauma, perivascular injection, guttural pouch disease, and strangles abscessation. The most common clinical sign is respiratory noise at work on inspiration described as a classic “roaring” noise. Exercise intolerance is another common complaint. Although occurrence can be documented in horses with resting endoscopy (graded I – VI), dynamic evaluation often demonstrates increased severity with lower grades or more infrequently adequate function for a given level of exercise.

Dynamic Grade	Description
A	Full abduction dynamically
B	Arytenoid/ vocal fold incomplete abduction
C	Severe dynamic laryngeal collapse with exercise



Surgical treatment options for LH include: prosthetic laryngoplasty, ventriculectomy, ventriculocorectomy, arytenoidectomy, and laryngeal reinnervation. The most common of these by far is prosthetic laryngoplasty (PLP) or tie back surgery. This technique involves the placement of a suture (the prosthesis) between the cricoid and arytenoid cartilage with the goal to mimic the abduction of the cricoarytenoideus dorsalis muscle permanently. Suture is tied to allow for sufficient airflow during exercise but not too excessive to result in entry of food/water into the trachea during swallowing.



Surgical approach is performed from the outer surface of the larynx on the affected side. The incision, approximately 8 cm long, is made just ventral and parallel to the linguofacial vein. Large #5 non-absorbable suture is placed through the caudal dorsal aspect of the cricoid cartilage and then through the muscular process of the arytenoid cartilage. Commonly 2 sutures are placed, one just slightly more lateral and then the first. Degree of abduction is assessed by placement of an endoscope intra-operatively while tightening and tying

the sutures. A more recent addition to the procedure has been describes and involves promoting ankylosis of the cricoarytenoid joint for improve stability and is being increasingly used by equine respiratory surgeons.<sup>3</sup>

Post operative management includes rest, anti-inflammatories, antibiotics, and feeding changes. Rest typically includes 2 weeks of stall rest, followed by 2 weeks of stall rest and handwalking, followed by 2-4 weeks of small paddock turnout or light exercise. Gradual return

Table 1  
Postoperative performance and complications after prosthetic laryngoplasty

No. operated horses	No. horses with follow-up	Percent satisfaction	Exercise intolerance after surgery (%)	Respiratory noise after surgery (%)	Coughing after surgery (%)	Reference
70	55	60	42	47	33	Russell and Sloan, 1994
80	69	70	25	9	—	Kidd and Sloan, 2002
230	176	81	—	25	26	Hawkins et al, 1997
104	79	92	6	21	9	Dixon et al, 1997
200	198	86	13	27	—	Kraus et al, 2003

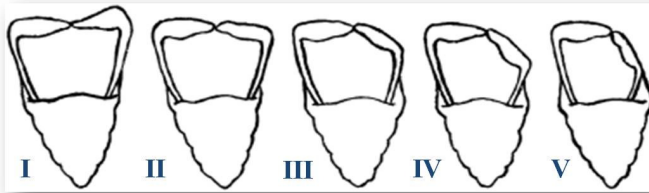
\*From Beard and Waxman, 2007 VET CLINICS

to normal exercise is allowed after 45-60 days. Feed changes include placing water, grain and hay on the ground and minimizing dust. This should be encouraged for the life of the horse to help decrease coughing and aspiration while eating. Prognosis post PLP surgery has reported ranges of success from 50-80% for racehorses and up to 94% in non-racehorses.<sup>4</sup>

Complications associated with PLP include failure (suture or cartilage), loosening or relaxation of the prosthesis, coughing, dysphasia, chronic aspiration, seroma or incisional infection, and persistence of respiratory noise. Of these coughing is the most common complication reported and can occur in up to 40% of cases post operatively. It is also important to note that not all horses will stop making

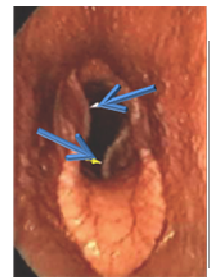
### Grades of post surgical abduction

Grade	Description
I	Close to or at maximal abduction and depresses the pharyngeal wall (80-90%)
II	High degree abduction, contacting pharyngeal wall (50-80%)
III	Moderate abduction, not touching pharyngeal wall (45%)
IV	Slight degree of arytenoid abduction, just over resting position
V	No abduction present

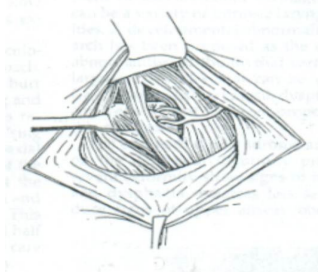


Hawkins et al (1997) and Davidson et al (2010)

respiratory noise post PLP surgery. Additional procedures may be required if noise is the primary concern. Evaluation of the tie back post operatively typically demonstrates some relaxation in the prosthesis. Grading system determining degree of post surgical abduction has been described.<sup>5</sup> One study by Davidson et al (2010) determined that dynamic collapse of the left corniculate process of the arytenoid cartilage occurred in horse with grade 5 post surgical abduction, but could not be predicted with grades 3 and 4.<sup>3, 6</sup> Dynamic endoscopy therefore was required to further evaluate these horses. In a case study with 45 horses post PLP that continued to make URT noise 76% of them demonstrated dynamic collapse with 96% of those having more than one structure involved. Structures commonly involved included vocal cord, aryepiglottic folds and arytenoid cartilage.



In addition to PLP, ventriculectomy or ventriculocordectomy is often performed as vocal fold collapse is commonly seen in horses with LH. In draft breeds it may be the only necessary procedure performed for the treatment of LH, allowing for decrease in noise production and sufficient airway diameter for work. One report of 92 cases ventriculocordectomy was the sole treatment.<sup>7</sup> Twenty-nine cases were performed unilaterally and 63 cases performed bilaterally. Of these cases 93% returned to work and owner reported success in 86% cases. 66% of these horses made no respiratory noise at work and less coughing was noted (22% vs. 43%) for previous reports post PLP surgery. Surgical techniques and post operative management are discussed below under vocal fold collapse. Arytenoidectomy is not commonly performed for LH unless there is gross abnormalities to the arytenoid cartilages (as with arytenoid chondritis) or if PLP has failed. The two described surgical techniques are the subtotal arytenoidectomy (where only the body of the arytenoid is removed) or a partial arytenoidectomy (where the body and corniculate process is removed). Of the two partial arytenoidectomy is by far the superior technique resulting in significant improvement in airway mechanics compared to the subtotal and being only slightly less or equivalent when compared to PLP.<sup>8</sup> The surgical approach for both techniques is through a ventral midline laryngotomy incision.



Laryngeal reinnervation, or neuromuscular pedicle graft, involves transposition of the ventral branch of the first cervical nerve and associated



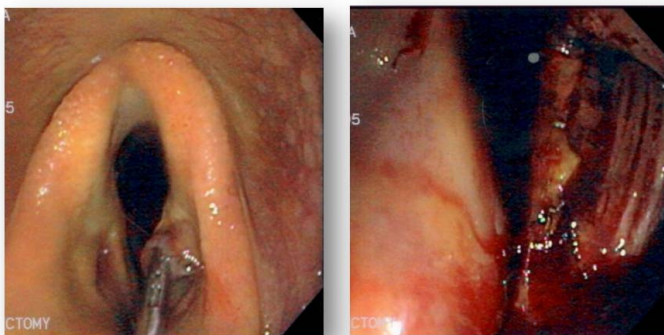
nerve branches from the omohyoideus muscle to the cricoidarytenoideus dorsalis muscle.<sup>9</sup> A ventriculocordectomy is also commonly performed at the time of surgery. Rehabilitation is key in the success of this procedure and duration between surgery and return to exercise is prolonged. Typical exercise plan is as followed: 2 weeks stall confinement, followed by 2 weeks small paddock turnout and 12 weeks total pasture turnout with no training, at 16 weeks start training introducing fast exercise as early and as frequently as possible. Endoscopy to determine function is performed 6 weeks after training begins. Fast and frequent exercise is needed to induce considerable respiratory effort which will allow for engagement of the omohyoideus via activation of the 1<sup>st</sup> cervical nerve. This nerve will now fire post operatively on the CAD muscle allowing for arytenoid abduction during exercise. Although described success has been reported, the long duration in return to exercise makes this an uncommon option for many owners/trainers.

**Vocal fold/cord collapse:**

Axial deviation the vocal folds or vocal cord collapse is a dynamic condition that can occur bilaterally or unilaterally. It is an idiopathic obstructive disorder that causes respiratory noise and exercise intolerance in horses. The vocal fold is a membrane structure that extends from the vocal process and attaches to the caudal boarder of the thyroid cartilage. The cricothyroid muscle is responsible for tensing and stabilizing the vocal fold in horses. Vocal fold collapse is often associated with laryngeal hemiplegia but can occur as a primary disorder. It has also been reported as a complication in a horse after undergoing a laryngeal tie forward procedure where damage to the innervation (external branch of the cranial laryngeal nerve) of the cricothyroid muscle was believed to have occurred. Vocal fold collapse has also been associated with head flexion in Norwegian Trotter horses.<sup>10</sup>



Recommended treatment is a ventriculocordectomy or ventriculectomy. This surgical procedure can be performed under general anesthesia or under standing sedation and surgical approach is either via a laryngotomy incision or transnasally with endoscopic guidance. Standing laser ventriculocordectomy is the most common approach and requires the use of bronchoesophageal forceps to grasp the affected cord(s) and a diode laser fiber to transect the cord. Post-operative management includes rest from exercise for 3 to 4 weeks, non-steroidal anti-inflammatories, ± antibiotics, and topical throat spray. Respiratory mechanics improve within 30 days post bilateral ventriculocordectomy and noise improvement is noted by 90 days post operatively. Complications are uncommon, but can include laryngeal and/or pharyngeal swelling, and granuloma formation at the surgery site.



When comparing outcomes between ventriculectomy vs. ventriculocordectomy on respiratory noise in draft horses with LH bilateral ventriculocordectomy resulted in improved airway mechanics and significantly less noise.<sup>11</sup>

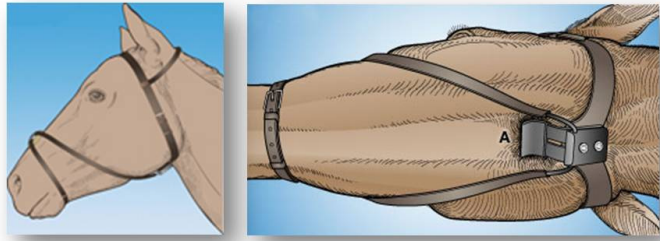
When comparing outcomes between ventriculectomy vs. ventriculocordectomy on respiratory noise in draft horses with LH bilateral ventriculocordectomy resulted in improved airway mechanics and significantly less noise.<sup>11</sup>

### Dorsal displacement of the soft palate (DDSP):

Dorsal displacement of the soft palate occurs when the soft palate becomes dislodged from the normal Subepiglottic position and obstructs the lumen at exercise. It can be persistent making it easy to diagnosis with resting endoscopy but is most commonly intermittent only occurring at work. It is a common cause of respiratory noise and poor performance and is estimated to occur in about 10-20% of racehorses. The etiology of DDSP is not completely known; however, a combination of causes have been implicated including upper respiratory inflammation, lower airway disease, dysfunction of pharyngeal nerves and increased caudal position of the larynx or elongation of the soft palate. Clinical signs are associated with decreased performance and respiratory noise heard on exhalation. Intermittent coughing may be noted in horses with persistent DDSP. DDSP can be present with other upper respiratory tract conditions such as laryngeal hemiplegia and epiglottic entrapment. Because the majority of cases are intermittent the diagnostic test of choice is dynamic respiratory endoscopy. A definitive diagnosis is made when the caudal boarder of the soft palate is visualized dorsal to the epiglottis for greater than 8 seconds. A complete evaluation of the URT via endoscopy is indicated in these cases including evaluation of the guttural pouches and trachea for conditions that could predispose the horse to DDSP and resolve if treated appropriately.

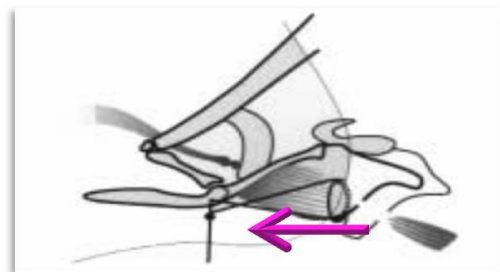


Treatment for DDSP can be medical or surgical. Medical therapy may help relieve local URT inflammation or lower airway disease that would resolve signs of DDSP in young horses. Treatment would include rest, topical or systemic anti-inflammatories, antibiotics and clenbuterol, and possibly inhaled steroids. Other non-surgical methods to prevent DDSP include the use of a tongue tie<sup>12</sup> or Cornell collar. Success with the use of a tongue tie has been questioned as there is no change in upper respiratory mechanics in normal horse associated with their use. The Cornell Collar, designed by researchers at Cornell Veterinary School, was designed to prevent caudal retraction of the larynx and has been demonstrated to be beneficial in

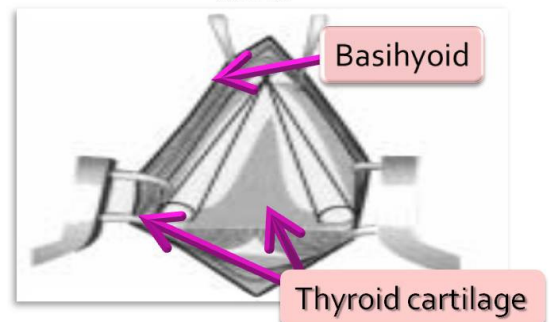


some cases.

There are numerous surgical techniques have been described for the treatment of DDSP and include: laryngeal tie forward, staphylectomy, laser palatoplasty, sternothyrohyoideus myectomy, epiglottic augmentation (if epiglottis is hypoplastic).<sup>4</sup> Combination of surgical techniques has also been employed. Of these the laryngeal tie forward is the current recommend surgical treatment of choice. This technique involves a ventral midline incision center along the ventral ramus of the mandible to approach the thyroid cartilage and basihyoid bone. Two sutures are placed, one on each side of the ventral caudal aspect of the thyroid cartilage with both ends going to the basihyoid bone to mimic the action of the thyroideus muscles by pulling the larynx forward. Often the laryngeal tie forward is combined with the



\*\* Overall goal is to pull the larynx more rostral by mimicking the thyrohyoideus muscle



sternothyroideus myotectomy. Post operative management includes 30-45 days of stall rest with hand walking followed by a gradual return to exercise, monitoring of the incision and feeding the horse with the feed and water raised off the ground. Prognosis has been reported at 82% with those horses demonstrating significant improvement in performance index and earnings.<sup>13, 14</sup> Complications associated with this procedure include: Seroma, incisional swelling, difficulty swallowing laryngeal granuloma and vocal fold collapse<sup>15</sup>.

Another very common surgical procedure is the Llewelyn or a parital sternothyroideus myectomy and tenectomy. This procedure involves a ventral midline incision centered over the cricoid cartilage the sternohyoideus muscles are bluntly separated to expose the tendon of insertion of the sternothyroideus on the thyroid cartilage. A 3 cm section of tendon and muscle is removed and the technique is repeated on the opposite side. Training can begin 2-3 weeks post operatively and success is variable with reports ranging between 58-70%.<sup>4</sup> Laser palatoplasty is another technique used in the treatment of DDSP with the goal of inducing palatal fibrosis. This procedure is also typically combined with a sternothyroideus myotectomy. The technique is performed via transendoscopic guided laser “cautery” along the caudal free margin of the soft palate extending rostrally approximately 2 cm. A staphylectomy can also be performed via endoscopic guidance where the caudal portion of the palate is actually removed. However, it is not common for horses to have elongated soft palates (unlike what is seen in dogs) therefore this technique is not commonly applied. Care must be taken to not remove too much of the soft palate allowing for disruption of the airtight seal and aspiration of feed material. Combined prognosis these therapies range from 60-65%.

Table 2  
Results of procedures used to treat dorsal displacement of the soft palate

Procedure	n	Percent success	Criteria for success	Percentage of horses included in percent success	Reference	Year
Midcervical sternothyrohyoidius myectomy	17	58	Subjective assessment	—	[37]	1988
Staphylectomy	69	59	Total earnings: three races before and after	42	[32]	1995
Midcervical sternothyrohyoidius myectomy	80	60	Total earnings: three races before and after	—	[32]	1995
Sternothyrohyoidius and partial omohyoideus myectomy	50	70	Earnings per start	100	[35]	1997
Sternothyroideus tenectomy	41	70	Race times	10	[38]	1997
Variety of surgical and medical	92	64	Earnings per start	49	[28]	2002
Sternothyroideus tenectomy and transnasal laser cauterization	52	92	Subjective assessment	—	[39]	2002
Sternothyroideus tenectomy, staphylectomy, thermoplasty	96	62	Total earnings	80	[34]	2005
Sternothyroideus tenectomy, staphylectomy, oral thermoplasty	102	63	Earnings per start	45	[27]	2005
Sternothyrohyoidius myectomy, staphylectomy, ventriculectomy	53	60	Earnings per start	49	[33]	2004
Tie-forward	116	87	Subjective assessment	—	[29]	2005
Epiglottic augmentation	59	66	Performance index	—	[30]	1997
Conservative	31	61	Earnings per start	—	[36]	2005

\*From Beard and Waxman, 2007 VET CLINICS

## **References**

1. Davidson EJ, Martin BB, Boston RC, Parente EJ. Exercising upper respiratory videoendoscopic evaluation of 100 nonracing performance horses with abnormal respiratory noise and/or poor performance. *Equine Vet J* 2011;43:3-8.
2. King DS, Tulleners E, Martin BB, Jr., Parente EJ, Boston R. Clinical experiences with axial deviation of the aryepiglottic folds in 52 racehorses. *Vet Surg* 2001;30:151-60.
3. Parente EJ, Birks EK, Habecker P. A modified laryngoplasty approach promoting ankylosis of the cricoarytenoid joint. *Vet Surg* 2011;40:204-10.
4. Beard WL, Waxman S. Evidence-based equine upper respiratory surgery. *Vet Clin North Am Equine Pract* 2007;23:229-42.
5. Hawkins JF, Tulleners EP, Ross MW, Evans LH, Raker CW. Laryngoplasty with or without ventriculectomy for treatment of left laryngeal hemiplegia in 230 racehorses. *Vet Surg* 1997;26:484-91.
6. Davidson EJ, Martin BB, Rieger RH, Parente EJ. Exercising videoendoscopic evaluation of 45 horses with respiratory noise and/or poor performance after laryngoplasty. *Vet Surg* 2010;39:942-8.
7. Taylor SE, Barakzai SZ, Dixon P. Ventriculocordectomy as the sole treatment for recurrent laryngeal neuropathy: long-term results from ninety-two horses. *Vet Surg* 2006;35:653-7.
8. Radcliffe CH, Woodie JB, Hackett RP, et al. A comparison of laryngoplasty and modified partial arytenoidectomy as treatments for laryngeal hemiplegia in exercising horses. *Vet Surg* 2006;35:643-52.
9. Ducharme NG, Horney FD, Partlow GD, Hulland TJ. Attempts to restore abduction of the paralyzed equine arytenoid cartilage. I. Nerve-muscle pedicle transplants. *Can J Vet Res* 1989;53:202-9.
10. Fjordbakk CT, Strand E, Hanche-Olsen S. Surgical and conservative management of bilateral dynamic laryngeal collapse associated with poll flexion in harness race horses. *Vet Surg* 2008;37:501-7.
11. Cramp P, Derksen FJ, Stick JA, et al. Effect of ventriculectomy versus ventriculocordectomy on upper airway noise in draught horses with recurrent laryngeal neuropathy. *Equine Vet J* 2009;41:729-34.
12. Beard WL, Holcombe SJ, Hinchcliff KW. Effect of a tongue-tie on upper airway mechanics during exercise following sternothyroid myectomy in clinically normal horses. *Am J Vet Res* 2001;62:779-82.
13. Ortved KF, Cheatham J, Mitchell LM, Ducharme NG. Successful treatment of persistent dorsal displacement of the soft palate and evaluation of laryngohyoid position in 15 racehorses. *Equine Vet J* 2010;42:23-9.
14. Woodie JB, Ducharme NG, Kanter P, Hackett RP, Erb HN. Surgical advancement of the larynx (laryngeal tie-forward) as a treatment for dorsal displacement of the soft palate in horses: a prospective study 2001-2004. *Equine Vet J* 2005;37:418-23.
15. Dart AJ. Vocal fold collapse after laryngeal tie-forward correction of dorsal displacement of the soft palate in a horse. *Vet Surg* 2006;35:584-5.