What to Expect Following Surgery of Obstructive Lesions of the Upper Respiratory Tract

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The results of upper airway surgeries vary with specific disorders and treatments. The descriptions of various surgeries for obstructive lesions and what is currently known about their outcome present equine practitioners with information that can be used for the appropriate selection of surgical candidates. Authors' address: D-202 Veterinary Medical Center, Michigan State University, East Lansing, MI 48824. © 1998 AAEP.

1. Introduction

The pharynx serves two primary functions: to act as a gateway to air entering the trachea and lower airway, and to serve as a conduit for food and water entering the esophagus. Because of the significance of these two functions in performance animals, the pharynx is of great importance when either of these functions is affected by disease processes. Because the upper airway (nasopharynx and larynx) has been identified as one of the areas of greatest impedance to airflow in normal animals, the work of breathing is greatly increased when upper airway obstructive lesions are present. Additionally, because of the close interrelationship of the upper airway's functions of breathing and swallowing, one of the major complications of surgery of the upper airway is compromised swallowing (dysphagia). Therefore, the goals of upper airway surgery are to establish an adequate upper airway opening during exercise while preserving the function of normal swallowing during eating.

Abnormalities of the arytenoid cartilages, the epiglottis, and the soft palate comprise the most common upper airway obstructions in performance horses in the form of laryngeal hemiplegia, epiglottic entrapment, and dorsal displacement of the soft palate. The literature holds a plethora of information from both clinical and experimental findings that attests to the importance of these common upper airway obstructions. What is currently known about the outcome following surgery for these obstructions follows.

2. Laryngeal Hemiplegia

The definitive diagnosis of laryngeal hemiplegia is made on endoscopic examination of the upper airway. The affected arytenoid cartilage assumes a paramedian position within the rima glottis and has limited to no movement (Fig. 1). The significance of partial dysfunction of the laryngeal abductor muscles, which results in limited motion of the arytenoid cartilage, is less clear and, therefore, a classification has been established (Table 1).1

When horses are affected by grade IV laryngeal movements at rest, the laryngeal aperture is reduced in size by an inability to abduct the affected arytenoid cartilage. Airflow reduction is exacerbated during maximal exercise by the dynamic col-
lapse of the unsupported arytenoid cartilage into the airway during inspiration. Therefore, horses with grade IV laryngeal hemiplegia are candidates for the laryngoplasty procedure. Horses with grade III laryngeal movements that suffer collapse of the arytenoid cartilage during exercise will benefit from the surgery as well.

A. Laryngoplasty

Laryngoplasty is the placement of prosthetic sutures between the cricoid and arytenoid cartilages, which, when tied, permanently abduct the affected arytenoid cartilage (Fig. 2). The efficacy of prosthetic laryngoplasty with and without bilateral ventriculocordectomy as a treatment for laryngeal hemiplegia has been examined experimentally.2 Prosthetic laryngoplasty returns upper airway function to near normal. Combining ventriculocordectomy with prosthetic laryngoplasty does not further improve upper airway function in horses (Fig. 3).2 Therefore, prosthetic laryngoplasty alone remains the primary treatment option for idiopathic laryngeal hemiplegia, especially when the athletic endeavors of the horse involve speed. Hence, racehorses, 3-day event horses, and other horses that perform at maximum speed should have this surgical procedure performed in preference to others. Additionally, horses that work with their head and neck in flexion, such as dressage horses, will be compromised by laryngeal hemiplegia during neck flexion because head position does alter airway mechanics, so that laryngoplasty will be needed. Other types of sport horses may benefit from less invasive surgery (see below).

Numerous complications have been reported following the laryngoplasty technique, with coughing (26%) and nasal discharge (16%) the most commonly encountered.3 These signs are not indications for suture removal and usually resolve over 2–3 months. Postoperative incisional infection and incisional seroma are rare. Incisional infections generally can be resolved by providing ventral drainage and antimicrobial and anti-inflammatory therapy.

For horses that are not used for athletic speed...
events, a prognosis for successful outcome after laryngoplasty is estimated to be 80–90%. However, in racehorses the prognosis for a successful outcome has been estimated to be between 48% and 85%, depending on the criteria used to evaluate success.4,5 Laryngoplasty eliminates noise in 65% of horses and improves postoperative racing performance in 69%.3 Laryngoplasty failure is unusual, but when it does occur, repeat laryngoplasty can be performed. Moderate abduction can be achieved with repeat laryngoplasty in most horses; however, 50% of racehorses will return to usefulness after a second laryngoplasty while 80% of nonracing horses improve sufficiently to be useful.6

Laryngoplasty is the preferred treatment for grade IV laryngeal hemiplegia in equine athletes expected to perform at maximum speeds.

B. Ventriculectomy

The removal of laryngeal saccules (sacculectomy, ventriculectomy) with (ventriculocordectomy) or without the removal of a section of the vocal fold has been advocated as a method to treat laryngeal hemiplegia. We know that ventriculectomy alone fails to improve upper airway flow mechanics and obstructions induced by laryngeal hemiplegia in strenuously exercising horses.7 However, ventriculectomy or ventriculocordectomy alone does have a place in treating certain sport horses with laryngeal hemiplegia.

For example, ventriculectomy will reduce the noise and fatigue induced by laryngeal hemiplegia in draft breeds used for both show and pulling contests, and it is routinely performed standing in these breeds. Additionally, show horses (western pleasure, hunters, etc.), especially with grade III laryngeal movements, will benefit greatly from bilateral ventriculocordectomy without laryngoplasty. Even racehorses with grade III laryngeal movements, in which abduction can be maintained during strenuous exercise but the vocal folds collapse, may be candidates for this technique. Complications are minimal with no reports of dysphagia following this procedure.

When performance speeds are required for the equine athlete, ventriculectomy is not recommended as the sole treatment in the presence of grade IV laryngeal hemiplegia. Ventriculectomy or ventriculocordectomy alone is an effective treatment for (grade IV) laryngeal hemiplegia in some equine athletes when speed is not required, or when arytenoid collapse does not occur (some horses with grade III laryngeal movements).

C. Arytenoidectomy

Arytenoidectomy can be performed for failed laryngoplasty or for arytenoid chondritis (Fig. 4). Two methods of arytenoidectomy have been described: subtotal, in which the muscular process and rim of the corniculate process are left intact, and partial, in which only the muscular process is left (Fig. 5). Airflow mechanics studies show that subtotal arytenoidectomy is not effective in reducing upper airway resistance created by laryngeal obstruction.8 However, partial arytenoidectomy is an effective treatment for airway obstruction involving the arytenoid cartilage.9 Partial arytenoidectomy should be combined with bilateral ventriculocordectomy, and all redundant loose tissue should be removed from the airway (Fig. 6). Tidal breathing flow volume loop analysis of this surgery shows that the procedure does not completely restore the upper airway to normal, but that partial arytenoidectomy is an effective treatment option for upper airway obstruction caused by arytenoid disorders (Fig. 7).

Complications do include dysphagia and chronic coughing. Some of this occurs from damage to the
pharyngeal nerve plexus during surgery. As nerve function returns over several months, this complication becomes self-limiting. However, horses should not be expected to return to training when coughing persists because aspiration pneumonia is a common complication. Owners are encouraged to feed the animal on the ground, and pasture feeding may be beneficial with this complication.

An arytenoidectomy does not completely restore upper airway function to normal, but it is an effective treatment for arytenoid problems when other techniques are not successful.

3. Epiglottic Entrapment

Envelopment of the epiglottis by the aryepiglottic fold (epiglottic entrapment) is a cause of upper airway obstruction and poor performance in the equine athlete. Pressure profiles in exercising horses support this clinical impression. Usually this condition is persistent and easily identified on videoendoscopy with the horse at rest (Fig. 8).

A. Surgical Release of the Aryepiglottic Fold

The entrapping aryepiglottic fold has been released by way of laryngeal, pharyngeal, transnasal, and transoral approaches that use a variety of surgical methods. However, resection of the aryepiglottic fold by way of laryngotomy has been associated with postoperative complications such as re-entrapment, epiglottic cicatrix, and persistent dorsal displacement of the soft palate. Aryepiglottic fold axial division techniques that obviate the need for laryngotomy reduce postoperative complications. Success with the transoral axial division technique performed with endoscopic guidance and the use of a hook bistoury is our preference. Transnasal approaches using electrocautery, hook bistoury, or laser techniques are also reported (see page 46).

B. Retrospective Study

A retrospective study examining surgical treatments for epiglottic entrapment in 51 horses showed that the transoral axial division of the epiglottic fold is recommended as an appropriate treatment for uncomplicated and persistent epiglottic entrapment. Resection by way of laryngotomy should be reserved for the treatment of epiglottic entrapment associated with excessively thick and scarred aryepiglottic folds and for intermittent epiglottic entrapment in horses for which surgical correction is deemed appropriate.

Axial division is the preferred method for the
treatment of epiglottic entrapment. Horses with epiglottic entrapment complicated by previous aryepiglottic fold surgery or another upper airway abnormality, particular epiglottic deformity or dorsal displacement of the soft palate, should receive a less favorable prognosis for return to athletic performance.

4. Dorsal Displacement of the Soft Palate
The most common nasopharyngeal pathology in racing horses is intermittent dorsal displacement of the soft palate (DDSP; Fig. 9). In this condition the caudal free margin of the soft palate becomes malpositioned dorsal to the epiglottis, creating a functional obstruction with the airway during exhalation. This airway obstruction usually creates an expiratory noise, but ~30% of horses with dorsally displaced palates do not make a respiratory noise.

A. Nonsurgical Management
Upper airway infection or inflammation should be treated with appropriate antimicrobial and anti-inflammatory medication followed by adequate rest before a diagnosis of irreversible intermittent DDSP is made. This becomes particularly important in young horses (2–3 years old) when inflammation is seen in the guttural pouch region around the pharyngeal branch of the vagus nerve. A large complex aggregation of lymph nodes is located ventral to this nerve. Therefore, a respiratory illness that results in inflammation of these nodes could, by their approximation to this nerve, cause inflammation and dysfunction. This nerve dysfunction could easily result in the intermittent form of DDSP. Therefore, treatment is directed toward the resolution of upper respiratory infection and inflammation. We prefer to use prednisone, interferon, and rest over a 30-day period (see Appendix A).

Head position may play a role in causing DDSP, in combination with a neuromuscular dysfunction of the soft palate. Recent studies have shown that compared with a normal head position, head and neck extension do not change upper airway impedance in normal horses; however, when in these same horses the head and neck were flexed, inspiratory resistance was increased approximately twofold during the inspiratory phase of respiration. Therefore, the horse should be allowed to extend its head and neck during racing if DDSP is suspected.

Additionally, it has been hypothesized that caudal retraction of the tongue elevates the soft palate and pushes the larynx caudally, both of which may predispose the horse to intermittent DDSP. Protraction of the tongue moves the hyoid apparatus and larynx cranially and causes nasopharyngeal dilation. Therefore, the use of a tongue tie has been suggested to help stabilize the nasopharynx. Other factors such as epiglottic entrapment, laryngeal hemiplegia, and arytenoid chondrosis may predispose a horse to DDSP, especially in the presence of some neuromuscular malfunction. These conditions should be treated prior to instituting therapy for DDSP.

B. Surgical Management
Failure to correct intermittent DDSP in exercising performance horses with medical and manipulative techniques within 60 days means that surgical intervention may be necessary. Currently, surgical therapy for DDSP includes partial myectomy of the laryngeal retractor muscles (strap muscle transection), sternothyroid tenectomy, partial staphylectomy, and epiglottic augmentation.

1. Myectomy of the Laryngeal Retractor Muscles
Contraction of the sternothyrohyoideus muscles during forced inspiration is hypothesized to result in caudal retraction of the larynx and predisposition of the horse to DDSP. The procedure for transection of the paired sternothyrohyoideus muscles is usually performed in a standing sedated horse by using local anesthesia in the midneck region. When race records were examined in horses that received a sternothyrohyoideus myectomy as treatment for DDSP, a successful outcome was obtained in 60% of the horses (35 Thoroughbreds and 13 Standardbreds). Complications after this procedure are unusual.

2. Sternothyroid Tenectomy
The sternothyroid tendon is transected at the level of the caudal larynx in the dorsally recumbent anesthetized horse. When this procedure is combined with myectomy of the laryngeal retractor muscles, the sternohyoideus and omohyoideus muscles are transected at the level of the larynx. This tendon lies just caudal to its attachment on the caudal border of the thyroid cartilage and is easily elevated into the surgery site by using a spay hook. The tendon is usually clamped with forceps and a 3-cm piece is removed. To our knowledge, there are no published...
3. Partial Staphylectomy
Removal of a portion of the caudal free margin of the soft palate for the treatment of DDSP has been advocated and is reported to be successful in a number of horses with this condition. In 69 horses undergoing partial staphylectomy for intermittent DDSP, 59% of the horses (11 Thoroughbreds and 30 Standardbreds) were successfully treated based on a comparison of earnings for three starts before and after surgery. The reason for this improvement is unclear. It may be partly due to a reduction in the amount of tissue obstructing the airway during displacement, or it may allow the horse to replace the palate in a subepiglottic position more readily by either increasing the size of the intrapharyngeal ostium or by stiffening the caudal border of the palate through scaring of the surgery site.

4. Epiglottic Augmentation
Epiglottic augmentation with polytetrafluoroethylene paste has shown great promise in correcting DDSP in racehorses, particularly when a juvenile or flaccid epiglottis is present (Fig. 10). Horses that have received epiglottic augmentation, with or without other surgery, appear to have a greater success rate than that previously reported for any individual surgery alone. The anesthetized horse is placed in dorsal recumbency and the epiglottis is approached through a laryngotomy incision. Between 3 and 7 ml of polytetrafluoroethylene paste is injected into the aryepiglottic fold until it is digitally determined to have an even thickness under the epiglottis. Care is taken not to inject paste near the base of the epiglottis, as this may prevent the free margin of the soft palate from obtaining a good air seal in this region. Therefore, just the cranial two thirds of the epiglottis should receive paste injections.

Endoscopically, these horses will have swelling that will occur over the next 3- to 7-day period that may produce some dysphagia and persistent DDSP (Fig. 11); however, this will abate within 30–60 days and the epiglottis should then assume a more normal appearance. Asymmetrical injections of polytetrafluoroethylene paste or overuse of this material can cause airway obstructions by producing a large bulge in the aryepiglottic fold. These subepiglottic Teflon masses may have to be surgically removed if this occurs.

In Thoroughbreds, racing performance after surgery was improved in 73% of the horses studied and was markedly better in Thoroughbreds that were 3 years of age or younger at the time of surgery compared with Thoroughbreds that were 4 years of age or older when this approach was used. When results for both Standardbreds and Thoroughbreds are combined, 66% had improved performance. Therefore, we recommend a multifaceted approach that includes the use of sternohyoid and omohyoid myectomy, sternothyroid tenectomy, partial staphylectomy, and epiglottic augmentation through a single incision located over the ventral larynx. This approach has been equally efficacious in horses with normal epiglottic anatomy and those that were treated for poor racing performance attributable to epiglottic hypoplasia and flaccidity, and therefore we have adopted this shotgun approach to surgery for DDSP until further information is known about its etiology.

We have approached the management of intermittent dorsal displacement of the soft palate by using a broad spectrum of suggested diagnostic manipulations and treatments. The initial use of medical and manipulative therapies, followed by surgical intervention when these techniques fail, has been our philosophy behind treating this condition. The approach to surgical management most often com-

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Fig. 10. Videoendoscopic appearance of the nasopharynx, epiglottis, and rima glottis of a horse during an inspiratory effort in the presence of nasal occlusion. The flattened appearance of the epiglottis and prominence of the aryepiglottic folds on its abaxial margin is the typical appearance of a flaccid epiglottis.

Fig. 11. Videoendoscopic appearance of the rima glottis of a horse, demonstrating swelling that is present 3 days after augmentation with polytetrafluoroethylene paste.
Appendix A: Treatment for Guttural Pouch Inflammation To Resolve Intermittent DDSP

1. Prednisone (50-mg tablet) dosage: 1 mg/kg PO q 12 h for 7 days (10 tablets/1000 lb), PO q 24 h for 7 days, and PO q 48 h for 14 days.

2. Interferon dosage: 100 units PO q 24 h for five treatments (see preparation below).

3. If horse has mucus in the trachea: nebulize the horse with 250 mg of Naxcel® q 12 h for 10 days to 2 weeks (optional).

The Preparation of a 100 units/ml solution of Roferon-A® for oral use is as follows.®

A. Supplies

The supplies include one vial of Roferon-A® at 3 million units/ml (this is the smallest commercially available package size). One liter of 0.9% sodium chloride (physiologic saline) for injection or irrigation is also required (the 1-L containers may have as much as 40 ml of overfill, and a total container volume up to 1040 ml). Several 30-ml (1 oz) bottles (which may be obtained from your local pharmacy) are also used.

B. Procedure

1. Remove 143 ml from the 1-L container of 0.9% sodium chloride, and save it for use in step 2. The 1-L container will now have approximately 897 ml; set it aside for use in step 3.

2. In a clean container, add 1 ml of Roferon-A® to 99 ml of 0.9% sodium chloride solution and stir well to mix thoroughly (DO NOT SHAKE to mix as this may damage the interferon). The final volume will be 100 ml and the solution will contain interferon 30,000 units/ml.

3. Add 3 ml of the solution prepared in step 2 (30,000 units/ml) to 897 ml of 0.9% sodium chloride solution (from step 1) and stir well to mix thoroughly (DO NOT SHAKE to mix as this may damage the interferon). The final volume will be 900 ml and the resulting solution will contain interferon 100 units/ml.

4. Divide the 100 units/ml solution into aliquots of 30 ml each, place in the 1-oz bottles, and store under refrigeration.

5. Label each bottle:
   - Interference α-2a 100 units/ml
   - Store in Refrigerator (2–8°C; 36–46°F)
   - Prepared: (date solution prepared)
   - Discard 30 Days After Preparation

6. Discard any solution remaining from steps 2–4, or any solution that remains at room temperature for more than 24 h. (Note that interferon tends to bind to surfaces, e.g., plastic and siliconized glass; the long-term storage of interferon solution requires a 70°C freezer and the addition of albumin to the dilute solution.)

References and Footnotes


Notes:
- Courtesy of Dr. Geoffrey Johnson, MS, RPh, Veterinary Teaching Hospital Pharmacy, Michigan State University, East Lansing, MI 48824.