Advances in
Equine Upper Respiratory Surgery
Advances in
Equine Upper Respiratory Surgery

Edited by

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*Advances in Equine Upper Respiratory Surgery* is edited by Dr. Jan Hawkins, a diplomate of the ACVS and a prominent surgeon in the field of equine upper respiratory surgery. Dr. Hawkins has assembled many of the leaders in this field with state-of-the-art presentations on disorders and treatments of the larynx, soft palate, guttural pouch, and trachea. The ACVS Foundation is proud to partner with Wiley-Blackwell in this important series and is honored to present this book in the series.

—Mark D. Markel  
Chair, Board of Trustees  
ACVS Foundation
Section I

Recurrent Laryngeal Neuropathy
Recurrent Laryngeal Neuropathy: Grading of Recurrent Laryngeal Neuropathy

Katie J. Smith and Padraic M. Dixon

Introduction

Equine recurrent laryngeal neuropathy (RLN) has long been recognized in larger breeds of horses as a cause of laryngeal airway obstruction with production of abnormal respiratory noise during work and with variable levels of reduced athletic performance (Christley et al. 1997; Dixon et al. 2001; Marks et al. 1970; Morris and Seeherman 1990). The characterization and subjective evaluation of the degree of RLN present in affected horses has been the subject of much debate. Methods employed in the assessment of laryngeal function include listening to the horse’s respiratory noise during exercise, palpation of the muscular process of the arytenoid cartilage to assess laryngeal muscle atrophy, and digital, endoscopic and electromyographic assessment of the laryngeal adductor reflex, laryngeal ultrasonography, and endoscopy, the latter of which has been the most commonly used technique for the past three decades.

Experienced clinicians can detect specific abnormal noise caused by RLN and subjectively assess the grade of RLN by noting the stage of exercise when the noise begins and by assessing the loudness and nature of any noise produced. In general, horses with milder degrees of RLN make more musical inspiratory “whistling” noises while more severely affected horses make harsher inspiratory and later biphasic noises, and do so after minimal work. However, there is no objective data on these correlations. Furthermore, fitter horses will make less noise than an unfit horse with a similar degree of RLN and some horses with endoscopically demonstrable low-grade RLN do not make any audible noise during exercise. Spectrum analysis of respiratory sounds recorded in exercising horses with a normal laryngeal endoscopic appearance and in horses with induced laryngeal hemiplegia has revealed unique patterns for RLN, characterized by specific frequency bands of inspiratory sounds (Cable et al. 2002; Derksen et al. 2001). However, the sensitivity and specificity of sound spectrograms (83% and 75%, respectively) indicate insufficient reliability to be used alone in dynamic investigation of upper airway abnormalities.

Palpation of the muscular process of the arytenoid can be used to detect cricoarytenoideus dorsalis muscle atrophy. The muscular process of the arytenoid on the affected side is discernibly more
prominent than the unaffected contralateral cartilage in cases with notable muscle atrophy. This test may be of use in horses with severe RLN that have gross muscle wasting, but is less reliable in the earlier stages of disease as lower grades of atrophy are commonly palpable in many large, clinically normal horses that have subclinical RLN. Laryngeal palpation is also less accurate in heavily muscled horses such as draft horses and ponies.

The laryngeal adductor reflex ("thoracolaryngeal or slap test") has been used to assess laryngeal adductor function. The absence of a rapid arytenoid adduction movement following slapping the contralateral saddle area assessed endoscopically or via palpation of the larynx can be attributable in some cases to disruption of the adductory component of the recurrent laryngeal nerve. However, this test has fallen out of favor due to its lack of reliability (Newton-Clarke et al. 1994). An electromyographic technique to evaluate the duration of this reflex (comparing the left and right sides of the larynx) also held great promise (Cook and Thalhammer 1991), until it was shown that normal horses have a slower reflex on the left side, likely due to the longer left recurrent laryngeal nerve (Hawe et al. 2001).

Ultrasonography has been used in laryngeal investigations (see Chapter 3) by assessing laryngeal adductor muscle atrophy and laryngeal dysplasia (Garrett et al. 2011). Although laryngeal adductor atrophy occurs ahead of abductor atrophy and this assessment has potential, there is little objective data on its value in grading the severity of RLN.

**Resting endoscopic grading**

Resting endoscopic assessment is currently the most common technique used to evaluate laryngeal function and indeed forms the mainstay of all upper airway assessments. Endoscopy to assess laryngeal function must be performed in unsedated horses (with the use of a twitch for restraint if necessary). There is a widespread consensus to use the right nasal passage when endoscopically assessing the larynx due to a purported reduction in artifactual changes in cartilage movement and positioning, although this has not been substantiated scientifically. The endoscope is inserted via the right ventral meatus and positioned midline in the nasopharynx. Arytenoid symmetry and synchrony are observed during quiet breathing, following swallowing (induced by trans-endoscopic laryngeal flushing) and during transient nostril occlusion to induce maximal abduction.

Despite the common use of resting laryngeal endoscopy, limited agreement between authors resulted in the development of multiple different grading systems, including the widely used four-grade system of Hackett and Ducharme (Hackett et al. 1991), the five-grade system of Lane (Lane et al. 2006), and the six-grade system of Dixon et al. (Dixon et al. 2001). In 2003, an international panel of specialists reviewed the existing laryngeal grading systems and developed a consensus system of resting laryngeal grading known as the Havemeyer grading system comprising four main grades (Robinson 2004). The Havemeyer grading system essentially uses the four-grade system of Hackett and Ducharme (Hackett et al. 1991) but with grades 2 and 3 divided into subgrades (Table 1.1) (Robinson 2004). The three subgrades of grade 3 in the Havemeyer system are equivalent to grades 2, 3, and 4 of the system of Dixon et al. (Dixon et al. 2001).

An important disadvantage of all resting endoscopic grading systems is the use of a static system to characterize a dynamic process where an infinite range of movements is possible. Specifically, there has been controversy regarding the clinical significance of various forms of asynchrony and/or asymmetry, predominantly of the Havemeyer laryngeal function grades 2 and 3.1. However, a general consensus is that the inability to achieve full abduction of the affected arytenoid cartilage during resting examination is likely to be associated with compromised respiratory function during exercise. In addition, experienced clinicians anecdotally concur that laryngeal asymmetry at end exhalation and asynchronous arytenoid movement during inhalation are not causes for concern if horses can attain and maintain full bilateral arytenoid abduction after swallowing or nasal occlusion.

Incomplete laryngeal abduction at rest was once viewed as equivocal in terms of its ability to accurately predict dynamic laryngeal function (Hackett et al. 1991; Hammer et al. 1998; Lane et al. 2006). This is attributable to the fact that in the four-grade system of Hackett and Ducharme (Hackett et al.
Table 1.1 Havemeyer grading system of laryngeal function in the standing unsedated horse a

<table>
<thead>
<tr>
<th>Grade character</th>
<th>Description</th>
<th>Sub-grade</th>
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<tr>
<td>1</td>
<td>All arytenoid cartilage movements are synchronous and symmetrical and full arytenoid cartilage abduction can be achieved and maintained.</td>
<td>2.1 Transient asynchrony, flutter, or delayed movements are seen. 2.2 There is asymmetry of the rima glottidis much of the time due to reduced mobility of the affected arytenoid and vocal fold but there are occasions, typically after swallowing or nasal occlusion when full symmetrical abduction is achieved and maintained.</td>
</tr>
<tr>
<td>2</td>
<td>Arytenoid cartilage movements are asynchronous and/or larynx is asymmetric at times but full arytenoid cartilage abduction can be achieved and maintained.</td>
<td>3.1 There is asymmetry of the rima glottidis much of the time due to reduced mobility of the arytenoid and vocal fold but there are occasions, typically after swallowing or nasal occlusion, when full symmetrical abduction is achieved but not maintained. 3.2 Obvious arytenoid abductor deficit and arytenoid asymmetry. Full abduction is never achieved. 3.3 Marked but not total arytenoid abductor deficit and asymmetry with little arytenoid movement. Full abduction is never achieved.</td>
</tr>
<tr>
<td>3</td>
<td>Arytenoid cartilage movements are asynchronous and/or asymmetric. Full arytenoid cartilage abduction cannot be achieved and maintained.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Complete immobility of the arytenoid cartilage and vocal fold.</td>
<td></td>
</tr>
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</table>

aDescription generally refers to the left arytenoid cartilage in reference to the right. However, this grading system can apply to the right side.

1991) (where grade 3 was not subdivided), did not sufficiently differentiate between horses not able to attain and maintain full arytenoid abduction. Thus, horses with slight asymmetry but able to achieve full arytenoid abduction were in the same category as those with marked asymmetry and incapable of attaining even moderate arytenoid abduction. Therefore, the addition of subgrades to grade 3 was advantageous in differentiating horses with varying degrees of asymmetry in order to accurately predict dynamic laryngeal function. Importantly, research correlating resting and exercising laryngeal endoscopy (Barakzai and Dixon 2011) has documented a statistical correlation between grades of (resting) Havemeyer laryngeal function grades and laryngeal function during exercise. These authors showed a significant correlation between the four main Havemeyer grades of laryngeal function at rest and laryngeal function at exercise. Notably, there was also significant correlation between resting subgrades 3.1, 3.2, and 3.3 and exercising grades of laryngeal function, validating the Havemeyer system for endoscopically evaluating horses at rest. The Havemeyer grades have been correlated with severity of histological abnormalities of the intrinsic laryngeal musculature (Collins et al. 2009). Correlations of the Havemeyer grades 2.1 and 2.2 with dynamic endoscopic grades have yet to be published.

One of the postulated disadvantages of using a more complex seven-grade/subgrade system as opposed to the previous four-grade system is the potential for variability during examinations. Significant inter- and intra-observer variability could introduce errors, which could have notable consequences in presale examinations or on decisions concerning laryngeal surgery. The observer variability and inter-horse repeatability using the Havemeyer grading system have been critically assessed (Perkins et al. 2009) and showed that reliability is high when experienced veterinarians conducted the endoscopic examinations. Importantly, there was moderate daily horse variability, which might suggest that results of endoscopy performed on a single day should be interpreted with caution. In addition, it has been recognized that there is a progressive deterioration of resting laryngeal function in approximately 12–15% of RLN-affected...
horses (Anderson et al. 1997; Davidson et al. 2007; Dixon et al. 2002).

Predictive value of resting laryngeal function

The sale of weanlings as training or resale prospects has prompted much evaluation of upper airway endoscopy in foals to determine if it can predict future racing performance. Major congenital abnormalities, including cleft soft palate, pharyngeal and subepiglottic cysts or laryngeal dysplasias, including branchial arch defects, will logically affect future athletic ability, unless they can be treated. Conversely, assessing laryngeal function in weanlings has been shown to be an unreliable predictor of laryngeal function as yearlings (Lane 2003).

In contrast to the unreliability of laryngeal endoscopic grading of foals, endoscopy in yearlings has shown more reliability as a predictive indicator of future performance (Garrett et al. 2010). In that study, a modified Havemeyer scale was employed, comprising grade 1, 2.1, 2.2, 3 (without subdividing grade 3), and 4. Analysis of the race records of horses at 2–4 years of age revealed that yearlings with grade 2.2 had fewer earnings than those with grade 1 or 2.1. A grade-3 laryngeal appearance was associated with fewer starts and less earnings at 3 and 4 years of age.

Dynamic grading

Laryngeal endoscopy during strenuous exercise (see Chapter 2) is the gold standard for assessing laryngeal function and is increasingly performed in the investigation of upper respiratory noise or poor performance using high-speed treadmill exercise at specialist referral centers and/or by overground endoscopy (Desmaizieres et al. 2009; Pollock et al. 2009). The subjective laryngeal function grading system used for dynamic laryngeal examinations is much simpler than that used for resting laryngeal evaluations (Table 1.2; Figure 1.1) (Robinson 2004) and has been altered little from the initial grading system suggested by Rakestraw (Rakestraw et al. 1991). Although studies have documented some variation between treadmill and field exercise, it remains unclear to what extent that incremental treadmill examination replicates racing conditions in the Thoroughbred or Standardbred racehorse. An investigation into the comparison of overground versus high-speed treadmill endoscopy concluded that there was no difference in the prevalence of dynamic laryngeal disorders between the two techniques (Allen and Franklin 2010).

**Table 1.2** Grading system of laryngeal function as assessed in the horse during exercise

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Full abduction of the arytenoid during inspiration</td>
</tr>
<tr>
<td>B</td>
<td>Partial abduction of the affected arytenoid cartilage (between resting position and full abduction)</td>
</tr>
<tr>
<td>C</td>
<td>Abduction less than resting position, including collapse into the contralateral half of the rima glottidis during inspiration</td>
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*Description generally refers to the left arytenoid cartilage in reference to the right. However, this grading system can apply to the right side.

Figure 1.1 Collapse of the left arytenoid during exercise (Grade C).

Post-laryngoplasty abduction grading

A grading system subjectively describing arytenoid positioning after laryngoplasty into five grades was
Recurrent Laryngeal Neuropathy: Grading of Recurrent Laryngeal Neuropathy

Figure 1.2 Grading of laryngoplasty abduction using five-grade system of Dixon et al. (2003).

<table>
<thead>
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<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Excessive abduction, that is, the affected arytenoid is close to or at maximal abduction (axial aspect of arytenoid at circa 80–90° to sagittal plane); hyperabducted with the apex of the corniculate process displaced beyond the midline, toward the normal side of the larynx</td>
</tr>
<tr>
<td>2</td>
<td>A high degree of arytenoid abduction (arytenoid at circa 50–80° to sagittal plane), i.e., less than complete abduction</td>
</tr>
<tr>
<td>3</td>
<td>A moderate degree of arytenoid abduction (arytenoid at circa 45° to sagittal plane)</td>
</tr>
<tr>
<td>4</td>
<td>A slight degree of arytenoid abduction, that is, arytenoid is slightly more abducted than the normal resting position</td>
</tr>
<tr>
<td>5</td>
<td>No detectable arytenoid abduction</td>
</tr>
</tbody>
</table>

*a* Description generally refers to the left arytenoid cartilage in reference to the right. However, this grading system can apply to the right side.

described in 2003 (Table 1.3; Figure 1.2) (Dixon et al. 2003). Using this system, the degree of arytenoid abduction was assessed on day 1, day 7, and 6 weeks after surgery, showing significant loss of abduction in most horses in the 6 weeks following surgery. The presence of postoperative dysphagia and coughing correlated significantly with the degree of abduction, indicating that excessive (grade 1) abduction should be avoided.

In a further study, postoperative race performance was assessed in relation to the degree of surgical abduction obtained using the above five-grade laryngoplasty abduction system (Barakzai 2009). The findings indicated that horses with excessive abduction (grade 1) were significantly more likely to lose abduction by day 6 after surgery than horses with moderate (grade 3) abduction. Importantly, the postoperative grade of abduction was not significantly correlated with markers of racing performance in National Hunt racehorses (Barakzai et al. 2009). However, there were very few cases with poor (grade 4 or 5) abduction included so conclusions regarding performance in such horses cannot be drawn.

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Recurrent Laryngeal Neuropathy: Diagnosis, Dynamic Endoscopy

Elizabeth Davidson

Introduction

For years, resting endoscopic evaluation of the upper airway has been used for assessment of laryngeal function. Horses with endoscopic evidence of complete paralysis of the laryngeal cartilage(s) at rest are easy to diagnose and their impact on performance is clear. Affected horses have upper airway obstruction and abnormal respiratory noise during strenuous exercise because of dynamic collapse of the affected arytenoid cartilage. However, the clinical significance of asynchronous or asymmetric laryngeal cartilage movement has been controversial. Endoscopic evaluation at rest may make the clinician suspect the possibility of laryngeal dysfunction during exercise but resting endoscopy does not replicate the function of the larynx during exercise. Therefore, dynamic exercising upper airway endoscopy is the gold standard for accurate identification of laryngeal dysfunction.

The use of exercising upper airway endoscopy to evaluate horses with exercise intolerance, respiratory noise, or poor performance is well documented (Dart et al. 2001; Kannegieter and Dore 1995; Lane et al. 2006; Martin et al. 2000; Tan et al. 2005) and dynamic upper airway observations from these treadmill studies have shaped our current knowledge of laryngeal function during exercise and remain the foundation of our understanding. One of the recent advances in the equine respiratory medicine is the advent of overground endoscopy which enables the clinician to instrument and evaluate the upper airway while the horse is exercising in its natural environment. Initial studies have validated its use as a viable alternative to treadmill endoscopy. Whether performed on the treadmill or overground, exercising endoscopy remains the best way to assess upper airway dynamics.

Treadmill endoscopy

Treadmill endoscopy is performed with the horse exercising on a high-speed treadmill. Equine treadmills are uniquely designed to exercise horses at racing speeds and are widely available at referral institutions. Although treadmill protocols vary among individual institutions, the basic process is similar, with the goal to mimic racing or show conditions. In general, horses are first acclimated to the treadmill. Horses are walked, trotted, and cantered...
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during the training session. Since most horses are not accustomed to treadmill exercise, the treadmill often evokes excitement and apprehension and a competent and patient horse-handling team is critical for familiarization and testing to proceed safely.

After acclimation, the treadmill exercise stress test is performed. Simulating race day conditions, horses undergo a warm-up phase of walking, trotting, and moderate cantering (trotting/pacing in Standardbreds) at approximately 7 m/s for 1600 m, analogous to the gallop to the starting gate. Following the warm-up the treadmill is stopped, and the endoscope is secured to the halter and the tip of the endoscope is positioned so that continuous visualization of the larynx is obtained. The high-speed test immediately follows with the horse exercising as fast as they are capable of. Ideally the horse should be capable of sustaining maximal speed for 1600–2400 m. Most referral centers with a high-speed treadmill employ an incremental speed (stepwise) treadmill test whereby the speed is increased over constant time intervals. For some horses, uphill exercise (1–3° incline) may be appropriate; this is especially true for horses used in competitions that include jumping (i.e., steeplechasing, eventing). Racehorses are exercised until target maximal heart rates (>200 beats per minute) are achieved or until the horse is fatigued to the point of not being able to keep up with the speed of the treadmill. The exact intensity is dictated by the fitness and temperament of the individual horse, but in many cases will approach 12–14 m/s. Depending on the institutions’ protocol and the horse’s temperament, the entire procedure from acclimation to testing takes 1–3 days to complete.

Overground endoscopy

Traditionally exercising endoscopy was performed on the high-speed treadmill. However, treadmill testing does not fully duplicate training or racing conditions. Factors such as the weight of the rider, excitement of race day, footing conditions, and the rapid changes of pace cannot be reproduced during treadmill testing. Therefore, exercising endoscopic examination in the field has advantages over treadmill endoscopy because the exercise test can be performed in the environment typically used for competition and horses can be examined in a manner appropriate for their discipline. For example, dressage horses can be examined in a collected frame and racehorses in company with other horses. In addition, the effect of track and rider can be accounted for and training sessions to acclimate horses to treadmills are not required. Disadvantages are minor and are related to inability to flush the endoscope on demand. Mucous accumulation on the camera or foggy image due to nasopharyngeal air temperature changes may occur because flushing on command is not possible.

Several commercially available overground endoscopic systems are available. The Dynamic Respiratory Scope (DRS®) system utilizes a backpack for electronics and lavage system which is secured to the rider’s saddle pad or sulky harness. The semi-rigid endoscope is secured in position via a specialized bridle. This system also includes a handheld viewer for remote real time visualization of the upper airway within a range of 500 m. The telemetric system records the entire examination and is battery operated for portability.

Key practical points to minimize difficulties when using the equipment include the following. Preparation of the horse and securing the endoscope in the correct position should be optimal because it is difficult to reposition the endoscope during exercise; only small adjustments are possible. Mounted endoscopy should be performed with an experienced rider; the newest DRS® models are fitted to saddle pads, not on rider. As with treadmill endoscopy, the DRS® does not negate resting endoscopic evaluation as gross anatomically abnormalities may preclude exercising examination. Resting endoscopy will also assess the horse’s compliance and cooperation.
Using the DRS®, exercising endoscopic observations in horses with recurrent laryngeal neuropathy (RLN) is comparable to those reported in treadmill endoscopy studies (Desmaizieres et al. 2009; Pollock et al. 2009). The ability to assess the effect of head and neck position, the rider, and other overground conditions are the main advantages of overground endoscopy.

Figure 2.1 Diagram illustrating grades of exercising laryngeal function: grade A, full abduction; grade B, incomplete abduction; grade C, severe collapse of arytenoid and vocal fold.

Figure 2.2 Exercising videoendoscopic appearance of the larynx of a horse with exercising laryngeal grade B. Note the concurrent collapse of the left vocal fold.

Figure 2.3 Exercising videoendoscopic appearance of the larynx of a horse with exercising laryngeal grade C. Note the severe collapse of the arytenoid and vocal fold.

Exercising laryngeal function

Whether the upper airway examination is performed on the treadmill or in the field, the goal of the examination in horses with RLN is to assess dynamic laryngeal function. During exercise, laryngeal function is categorized as grade A, B, or C (Figure 2.1) (Rakestraw et al. 1991). Horses with exercising laryngeal grade A are able to obtain and maintain full abduction of the arytenoid cartilages during inspiration. Horses with exercising laryngeal grade B are able to maintain the affected arytenoid in a relative fixed but incompletely abducted position; a position between full abduction and resting position (Figure 2.2). Horses with exercising laryngeal grade C have severe dynamic collapse of the affected arytenoid cartilage and vocal fold during exercise with abduction being less than a resting position (Figure 2.3).

Resting versus exercising laryngeal grading systems

The vast majority of laryngeal endoscopic assessment is done in the resting, standing horse and RLN
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Grading systems have been developed to characterize and categorize resting laryngeal movements. The three most commonly used resting laryngeal function grading systems are the four-grade system (Hackett et al. 1991), the five-grade system (Kannegieter and Dore 1995; Lane et al. 2006), and the six-grade system (Dixon et al. 2001). Of the three systems, the four-grade system is most widely used. A seven-grade “Havemeyer” system (Robinson 2004) was developed by a panel of respiratory experts in hope that clearly defined criteria would help minimize variability and therefore result in a reliable and consistent system. It is an amalgamation of the four, five, and six grading systems and represents a consensual agreement of respiratory clinicians worldwide.

The real value of any resting grading system is its correlation with laryngeal function during exercise. The combined results of numerous treadmill studies (Barakzai and Dixon 2011; Davidson et al. 2011; Franklin et al. 2006; Lane et al. 2006; Martin et al. 2000) indicate there is good correlation between resting laryngeal grades and exercising laryngeal function. The majority of horses that are able to fully abduct their arytenoid cartilages at rest will have normal laryngeal function during exercise (exercising laryngeal grade A). On the contrary, horses with complete immobility of the arytenoid cartilage at rest will have axial collapse of the affected arytenoid and vocal cord during exercise (exercising laryngeal grade C). However, between 1% and 7% (Barakzai and Dixon 2011; Garrett et al. 2011; Lane et al. 2006; Martin et al. 2000) of horses with “normal” resting laryngeal grades will experience dynamic arytenoid cartilage collapse during exercise. Presumptive assumption of exercising laryngeal function based on resting endoscopy is not correct in all horses.

Horses with asynchronous and/or asymmetric arytenoid cartilage movements that cannot achieve or maintain full arytenoid abduction (Havemeyer laryngeal grade 3) deserve special consideration. Previous reports vary regarding the proportion of horses with this “equivocal” resting laryngeal grade that are able to maintain arytenoid abduction versus those that experience arytenoid cartilage collapse during exercise. The initial treadmill study (Rakestraw et al. 1991) indicated that only 16% of grade 3 (using the four-grade system) horses experience dynamic collapse of the arytenoid cartilage. Subsequent studies (Dart et al. 2001; Hammer et al. 1998; Martin et al. 2000) refuted those results citing that the majority, 77–88%, of grade 3 horses will have axial collapse of affected arytenoid cartilage during exercise. Another treadmill study (Lane et al. 2006) using the five-grade system found only 40% of horses with grades 3 or 4 were unable to maintain arytenoid cartilage abduction at speed. In another study using the Havemeyer seven-grade system (Barakzai and Dixon 2011), 66% of grade 3 horses had dynamic arytenoid cartilage collapse and the likelihood of collapse increased with increasing Havemeyer subgrades 3.1, 3.2, 3.3. While it appears that the majority of grade 3 horses are unable to maintain laryngeal abduction during exercise, exercising endoscopy is clearly indicated for affected horses, especially subgrades 3.1 and 3.2.

The combined results of numerous treadmill studies indicate that failure to obtain and maintain arytenoid cartilage abduction at rest is the major criterion to determine the probability of abnormal laryngeal function during exercise. However, these studies also confirm that decisions about laryngeal function of horses that rely solely on resting endoscopy and do not include an exercise test are inadequate. While recognized associations between resting and exercising laryngeal function may provide general guidelines about the likelihood of dynamic laryngeal function, or dysfunction, not all horses should receive predetermined exercising assessments based on resting laryngeal grades. Clinicians should make individual patient assessments, not assessments based on groups of horses, and whenever possible perform exercising endoscopic evaluation of the larynx. Resting endoscopic examination should not be used as the only diagnostic method, especially in horses with questionable laryngeal function.

Bilateral laryngeal collapse

Bilateral laryngeal dynamic collapse is an abnormality that has been primarily reported in Norwegian Coldblooded Trotters (Strand et al. 2009). This disorder is characterized by marked bilateral collapse of the vocal folds and concurrent bilateral loss of arytenoid cartilage abduction during exercise (Figure 2.4). Diagnosis can only be made by
exercising endoscopy. Upper airway obstruction is observed when the affected horse is driven into the bit and tension is applied to the long reins. An uncommon manifestation of RLN has been suggested as the etiology of this disorder. Affected horses are able to obtain and maintain full arytenoid abduction during resting endoscopic evaluation and during treadmill endoscopy without rein tension, it is unclear if RLN is the primary cause of this condition; neuromuscular histopathology has not been performed. Another proposed cause is that the disorder is secondary to conformation changes in the throat region associated with head and neck flexion and the small airway diameter of certain breeds. Bilateral laryngeal collapse has also been infrequently identified in other breeds/disciplines (Davidson et al. 2011) exercised with flexed neck and rein tension.

Dynamic collapse of the apex of corniculate process

Dynamic collapse of the apex of the corniculate process of the arytenoid cartilage is an uncommon laryngeal obstructive disorder. It has been reported in 4–6% of horses undergoing treadmill endoscopy (Barakzai et al. 2007; Dart et al. 2001, 2005; Tan et al. 2005). It is characterized by the apex of one corniculate process, usually the left, luxating to a position that is ventral and axial to the other corniculate process. The corniculate cartilage maintains abduction and does not axially collapse into the airway; it just slides ventral to the other. Concurrent dynamic collapse of other upper airway structures such as the aryepiglottic fold is common as the horse becomes fatigued. Although the underlying etiology of axial collapse of the corniculate process is unknown, it has been speculated that this disorder may be an atypical form of RLN.

The adductor branch of the recurrent laryngeal nerve and the adductor muscles, including the arytenoideus transversus muscle, are more severely affected (Duncan et al. 1991) in horses with RLN. Severe atrophy of the transverse arytenoid muscle may result in insufficient function and loss of the dorsal articulation between the right and left arytenoid cartilages. Without dorsal support, the apex of one corniculate process may be predisposed to collapsing under the other corniculate as airway pressure increase during exercise. Another proposed etiology is that the disorder may not be attributed to RLN but to an aberrant transverse arytenoid ligament. Histological findings of one horse revealed an enlarged wide transverse arytenoid ligament resulting in gap formation between the dorsal margins of the corniculate processes (Barakzai et al. 2007).

Vocal fold collapse

Axial collapse of the vocal fold is considered to occur passively as a result of arytenoid cartilage collapse (Figures 2.2 and 2.3). When there is loss of cricoarytenoideus dorsalis muscle function, there is decreased tension on the vocal fold predisposing it to collapse during exercise (Holcombe et al. 2006). Dynamic collapse of the vocal fold occurs with increased frequency as the resting laryngeal grade increases from 1 to 4 and with increasing subgrades of grade 3 (Barakzai et al. 2011). However, vocal fold collapse has also been reported in horses which are capable of maintaining adequate arytenoid abduction during exercise (Dart et al. 2001; Franklin et al. 2006; Kannegieter and Dore 1995; Lane et al. 2006; Martin et al. 2000). In these horses, solitary collapse of the vocal fold without concurrent arytenoid cartilage collapse likely reflects the pathology of the
cricothyroid muscle and is not unusual endoscopic evidence of RLN.

Enforced poll flexion

Flexion of the poll has been shown to increase upper airway impedance in normal horses (Petsche et al. 1994). This is particularly important in horses which are required to exercise with a flexed head and neck, for example, show (combined driving, gaited, or show jumping) or dressage horses. In some horses with RLN, dynamic arytenoid cartilage collapse is only evident or markedly exacerbated when horses are exercised with enforced poll flexion (Davidson et al. 2011; Franklin et al. 2006; Van Erck 2011). Since this position is a contributing factor for the development of laryngeal collapse, exercising endoscopic evaluation with and without head and neck flexion should be performed in horses in suspected laryngeal dysfunction, especially those which are ridden with poll flexion.

Progression of RLN

Although it is commonly believed that complete arytenoid cartilage paralysis is preceded by progressive deterioration, few reports validate this statement (Anderson et al. 1997; Davidson et al. 2007; Dixon et al. 2002; Garrett et al. 2011). The reported incidence of RLN progression is low 5–15% (Anderson et al. 1997; Dixon et al. 2002) and slows with a median period of 12 months (Dixon et al. 2002). Progression of the disease is most commonly identified by deterioration of laryngeal function at rest combined with the onset of abnormal-exercise-related respiratory noise (Anderson et al. 1997; Dixon et al. 2002). Progressive loss of laryngeal function has also been identified during repeated treadmill endoscopic evaluation of horses (Davidson et al. 2007; Garrett et al. 2011).

Implications of RLN in show horses

Compared to racehorses, RLN does not always impede the performance of the show horse; they are able to compete despite laryngeal dysfunction. Research studies have demonstrated that at exercise intensities less than VO₂peak, RLN does not have significant physiological consequences (Ehrlich et al. 1995) which may explain why some show horses can compete successfully despite the disease. Treadmill reports indicate that resting laryngeal grade 3 horses are less likely to have dynamic arytenoid cartilage collapse when exercised at submaximal intensities (Davidson et al. 2011; Rakestraw et al. 1991) compared to maximally exercised racehorses (Dart et al. 2001; Hammer et al. 1998; Martin et al. 2000). Brakenhoff observed RLN (resting laryngeal grade 3 or 4) in 35% of adequately performing competitive draft horses. In fact, some of the highest placed horses had untreated laryngeal dysfunction (Brakenhoff et al. 2006). At lower than maximal exercise intensities, the aerobic capacity of a horse affected with RLN seems to be adequate for many nonracing endeavors. However, since RLN can be progressive, declines in performance or abnormal respiratory noise are impetuses for additional endoscopic evaluation.

References


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