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 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 left 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 analogously 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. 1991).
Table 1.1 Havemeyer grading system of laryngeal function in the standing unsedated horse

<table>
<thead>
<tr>
<th>Grade character</th>
<th>Description</th>
<th>Sub-grade</th>
</tr>
</thead>
<tbody>
<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.</td>
</tr>
<tr>
<td></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>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>3</td>
<td>Arytenoid cartilage movements are asynchronous and/or asymmetric. Full arytenoid cartilage abduction cannot 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.</td>
</tr>
<tr>
<td></td>
<td>Arytenoid cartilage abduction is evident and full abduction is achieved but not maintained.</td>
<td>3.2 Obvious arytenoid abductor deficit and arytenoid asymmetry. Full abduction is never achieved.</td>
</tr>
<tr>
<td></td>
<td>Arytenoid cartilage abduction is evident and full abduction is never achieved.</td>
<td>3.3 Marked but not total arytenoid abductor deficit and asymmetry with little arytenoid movement. Full abduction is never achieved.</td>
</tr>
<tr>
<td>4</td>
<td>Complete immobility of the arytenoid cartilage and vocal fold.</td>
<td></td>
</tr>
</tbody>
</table>

*Description 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...
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).

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 7

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

Table 1.3 Postoperative grade of laryngeal position

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<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); hyperabduced 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 the 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>

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

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.

References


Collins N, Milne E, Hahn C, Dixon PM. 2009. Correlation of the Havemeyer endoscopic laryngeal grading system with histopathological changes in equine


