



Diagnosis of upper respiratory tract diseases in the performance horse

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Diagnosis of decreased athletic performance is a significant challenge, because many of the problems are subtle, manifest only at high speeds, or may have multiple concurrent problems. Comprehensive testing of these horses is often necessary to ascertain the definitive cause of poor performance. Many disease processes can be a factor in a poorly performing horse; however, respiratory disease is commonly the cause. Respiratory disease was identified in 40% to 42% of racehorses presented for poor performance evaluation [1,2]. Of the horses identified with respiratory dysfunction, dorsal displacement of the soft palate was the most commonly identified respiratory disorder, affecting 29% to 35% of racehorses [1,2]. Laryngeal hemiplegia was identified in 17% to 24% of the racehorses [1,2]. Pharyngeal collapse was identified in 27% in one study [1] and in only 1.5% [2] in another study. Retrospective analysis of sport horses presented for poor performance also identified respiratory disease disorders in 54 of 77 (70%) sport horses. Laryngeal hemiplegia was identified in 40% of these horses. Dorsal displacement was identified in only 11%, and pharyngeal collapse was identified in 30%. Results of the retrospective analysis of sport horses suggest that respiratory compromise may be overrepresented in this population. Additionally, laryngeal hemiparesis and pharyngeal collapse represent most of the respiratory problems in sport horses.

Desired breed characteristics and selected gaits and movements may have a profound affect on respiratory function. Elevated head and neck carriage, a desired style for certain events of sport horses, can have an impact on the normal anatomic relation of the upper airway, resulting in increased respiratory compromise [3]. In addition, a respiratory noise, a clinical

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manifestation of respiratory dysfunction, may be considered an “unsoundness” even if this noise does not affect the horse’s physical ability to perform its job. These qualities and conditions can make respiratory diseases in sport horses a significant cause of poor performance.

Defining the performance in a performance horse

As a veterinarian working with performance horses, it is essential that one have a working knowledge of the horse’s discipline. If one can understand what is asked of the horse and what are the desired characteristics of each breed and the demands of each competition, the veterinarian can be better equipped to fully evaluate the horse for its poor performance issues.

Racehorses have a defined measure of performance. They must win races. Sport horse performance is more difficult to define. A sport horse’s performance is often judged in relation to the other competitors. Performance may be compared with previous performances and/or the rider’s preconceived expectations. Any deviations from “normal” can be the difference between an elite show horse and an average riding horse. What defines performance is often intangible. It may be the elegance of a particular movement or the sheer jumping ability. Airway obstructions can have a profound impact on performance, limiting the physical ability of the horse. Clinically, respiratory impedance is often manifested as a noise. In certain disciplines, a respiratory noise is considered an “unsoundness,” affecting the quality of the performance.

Defining what is the ideal performance is variable among equestrian disciplines. Therefore, respiratory dysfunction may affect each horse differently relative to its type of activity. For example, Quarter Horses competing in barrel racing, judged on speed alone, may compete successfully if the respiratory disease does not affect the racing ability. In another arena, the Western Pleasure Quarter Horse may be able to compete with some degree of respiratory compromise as long as the condition does not affect its gaits or movements. Saddlebreds, Arabians, and Morgans are judged on the basis of appearance, often being asked to exhibit with an elevated head and neck carriage and exaggerated limb movement. This type of head carriage often alters the relation of the normal anatomic structure, resulting in increased respiratory compromise [3]. Similarly, the transition from third- to fourth-level dressage movements seems to be the level at which mild respiratory dysfunction becomes a concern for the horse and rider, preventing the horse from performing the upper-level movements. This may be a result of the degree of collection asked of these horses and, hence, the head and neck positions often narrowing the upper airway. Three-day eventing is a demanding sport for the horse and rider. Even the slightest respiratory noise may be the result of mild respiratory dysfunction and may

affect the horse's ability to finish the cross-country phase of the event. In the hunter ring, a respiratory noise is considered an unsoundness. Although a respiratory noise may not affect the horse's physical ability to jump a course of 3-ft 6-in fences, the noise is considered inappropriate. Jumpers are allowed to make a noise as long as they can do their job; however, as the jumps get higher and wider and the courses get increasingly more demanding, respiratory compromise can significantly affect performance.

Examination of the upper respiratory tract at rest

Physical examination

A complete and thorough physical examination should always be performed first when evaluating horses for upper respiratory tract dysfunction. Physical examination abnormalities of importance include asymmetry of the external nares. By placing a hand over the external nares, a crude estimate of airflow can be appreciated. Any resistance or complete absence of airflow is significant. Symmetry of the facial bones should also be evaluated. Although a "dished" head is highly desirable in Arabians, it is not a common clinical examination finding in Warmblood breeds and should be noted. External palpation of the larynx may also be helpful. Experienced fingers can detect subtle arytenoid deformities. A prominent muscular process of the arytenoid, the result of cricoarytenoid dorsalis muscle atrophy, can be detected in horses affected with laryngeal hemiplegia. The cervical trachea should also be evaluated for evidence of tracheal ring deformities or tracheal collapse.

Because sport horses frequently compete into their later years, ownership of the horse may be variable. The historical information on surgical intervention may not be available or may not have been disclosed to the current owner. One must be an astute diagnostician in these cases. Common regions of surgical intervention include the nasal, facial, and maxillary bones for sinus surgery. The presence of white hairs or thickening of the bone and/or periosteum in these regions may be the result of previous sinus surgery. Thickening of the ventral throatlatch region may be the result of a previous laryngotomy. Surgical intervention for soft palate dysfunction should be considered. External evidence of a prosthetic laryngoplasty is often difficult to identify. Clipping of the hair in the region of the left linguofacial vein may facilitate the identification of a surgical scar.

Videoendoscopic examination

Examination of the upper airway with a videoendoscope includes evaluation of the nasal passages, nasopharynx (including the nasomaxillary opening), ethmoid recess, larynx, guttural pouches, and cervical trachea.

When evaluating the nasal passages, it is critical to evaluate both the right and left nasal passages. Soft tissue masses or deviations of the nasal septum can be a cause of respiratory noise. The nasomaxillary opening should be examined for evidence of discharge from the sinuses. The ethmoid recess area should also be evaluated for the presence of a hematoma or other mass.

The size and shape of the structures of the pharynx and larynx should be noted. Gross abnormalities of the laryngeal cartilages and the size and shape of the epiglottis should be noted. The position of the soft palate and the ease with which it dorsally displaces should also be noted. Resting evaluation of palate function does not always correlate with function during exercise, however [1,2,4,5]. Treadmill testing of these cases may be essential for evaluation.

Three techniques have been used for assessment of laryngeal and pharyngeal function at rest. To induce arytenoid movement, the “slap test” may be performed by slapping patients on the chest. In horses with intact spinal reflexes, the contralateral arytenoid adducts when the patient is slapped. The inability of the arytenoid to adduct is suggestive of laryngeal hemiplegia. Another technique is manual occlusion of the nostrils during endoscopy by resting the palm of the hand on the nasal bone and using the thumb to collapse one nasal passage and the fingers to obliterate the other nasal passage [6]. This maneuver can cause reflex adduction and abduction of the arytenoids by forcing the horse to breathe more deeply. It has been suggested that negative tracheal and pharyngeal pressures achieved during nasal occlusion are equal to or greater than exercising upper airway pressures [7]. Observation of horses with a history of poor performance undergoing nasal occlusion demonstrated a poor correlation between resting and exercising upper airway function, however. Horses that displaced the soft palate at speed did not displace their palates more frequently at rest than other horses [4]. Also, all horses had some degree of pharyngeal collapse during nasal occlusion; however, they failed to demonstrate collapse during speed [4]. Stimulation of swallowing is accomplished by instillation of water through the biopsy chamber of the flexible fiberoptic endoscope or by gentle manual pressure with biopsy forceps. Immediately after swallowing, maximal abduction and adduction of the arytenoids are noted [6,8]. Consistent assessment of laryngeal function after swallow reflux has been reported [4].

Subjective grading of arytenoid function is used to classify arytenoid movement at rest [9]. Horses with grade I and II laryngeal hemiparesis are able to achieve full abduction at rest and are usually able to fully abduct the arytenoid during exercise. Approximately 77% of horses with grade III laryngeal hemiparesis (incomplete abduction at rest) have significant arytenoid dysfunction during exercise [10]. Treadmill testing of these horses is critical in making treatment recommendations. Horses with grade IV laryngeal hemiplegia are easily diagnosed at rest. Racehorses affected with severe laryngeal hemiplegia often do not require further testing to assess

respiratory dysfunction; however, certain conditions of sport horses with degrees of laryngeal dysfunction may require further evaluation on the treadmill. For example, a dressage horse with a known laryngeal hemiplegia that has recently developed a respiratory noise or an event horse with partial paralysis at rest is an example of a horse that requires further testing.

Videoendoscopic evaluation may also help to identify past surgical intervention. The absence of a ventricle or vocal fold or the immobility of an arytenoid is a clear indication of previous prosthetic laryngoplasty. A faint scar may also be seen in the ventral floor of the larynx as the result of a laryngotomy. A “notched” appearance of the caudal free edge of the soft palate indicates a previous staphylectomy. Further testing of operated horses may be necessary to assess the current state of the pharynx and larynx. Failure of previous surgery and/or the presence of a new problem should be ascertained.

Radiographic evaluation

In horses with suspect sinus or nasal passage abnormalities, radiographic evaluation may be necessary to appreciate fully the extent of disease. Deviation of the nasal septum can be a cause of respiratory noise. Large masses within the sinus or nasal passage can also affect airflow, creating turbulence and respiratory noise. Radiographic evaluation is less useful for assessing the larynx and pharynx in most cases. Exceptions include mineralization of the arytenoids.

Examination of the upper respiratory tract during exercise

Instrumentation

Exercising evaluation of the upper airway is indicated in horses without obvious abnormalities at rest, with questionable laryngeal function, or with a history of an abnormal respiratory noise. High-speed treadmill evaluation is an excellent tool for evaluating exercising horses. Endoscopic evaluation may be performed immediately after exercise in an attempt to appreciate exercising abnormalities [6]; however, in the authors' experience, by the time the horse and the videoendoscope are in the same room, the respiratory dysfunction cannot be fully appreciated.

Most horses with dynamic airway obstruction have a history of abnormal respiratory noise. The absence of noise does not eliminate the presence of upper respiratory tract dysfunction, however [1,11,12]. Therefore, noise alone should not be the only factor that determines which horses should undergo high-speed treadmill videoendoscopic evaluation.

The use of videoendoscopic evaluation of the upper respiratory tract is well documented [1,2,4,5,8,10,12–15]. High-quality videoendoscopic equipment is recommended. The videoendoscope must be secured to the halter of

the exercising horse, providing stabilization of the image during the rapid head movements of a galloping horse. Recording the entire examination and reviewing the examination in slow-motion frame-by-frame playback is quite helpful, because abnormalities may occur rapidly during respiration.

The protocol for exercising evaluation varies for each academic institution. Established protocols for racehorses have been developed. Goals are to mimic the racing conditions. The protocol used at the authors' academic institution is a "step test" for racehorses. Thoroughbreds and Standardbreds are first introduced to and schooled on the treadmill at slow speeds so as to acclimate the horse to the apparatus. Standardbreds are equipped with a harness and bridle and Thoroughbreds with a halter only. After a schooling session, the high-speed test is performed. For Standardbreds, the speed is rapidly increased to 9 m/s for 400 meters, to 10 m/s for 400 meters, and to 11 to 14 m/s over the next 1600 meters depending on the capabilities of the individual. Standardbreds are exercised without an incline. For Thoroughbreds, the treadmill speed is increased to 9 m/s for 400 meters, and the treadmill is then elevated to an incline of 3°. Speed is increased to 11 m/s for 400 meters and then to 12 to 14 m/s for an additional 1600 meters. The last 400 meters is performed at a speed of 12 m/s without an incline. Racehorses are exercised until maximal heart rates are achieved or until the horse is fatigued to the point of not being able to keep up with the speed of the treadmill.

When evaluating performance horses during exercise, strict protocols are impossible to follow. The speed and length of the exercising test must be adjusted to the individual horse. For example, an advanced-level event horse may be tested at a maximum speed of 10 m/s for a total distal of 3500 meters to simulate the cross-country phase. A show jumper may be tested a speed of 11 m/s at an incline of 1° to 2° for a total distance of 2000 meters to simulate the physical exertion obtained during a course of 10 5-ft fences. In addition, any equipment or tack may be implemented to replicate the conditions under which the respiratory noise occurs. Side reins may be implemented to simulate a flexed head and neck condition. A driving harness may also be appropriate for Morgans or draft horses.

Although respiratory dysfunction is a common cause of poor performance, other diseases can be a contributing factor to poor performance. A complete and thorough exercising test is recommended in these horses. Other diagnostics that can be performed while exercising include cardiac evaluation. Using radiotelemetry, exercising electrocardiography can be performed. Goals for treadmill evaluation are to reach exercising heart rates of 200 beats per minute (bpm) to ensure maximal cardiac exertion. Additionally, cardiac arrhythmias can be identified. Pre- and postexercising echocardiography can be useful in detecting cardiac abnormalities. In a retrospective study, 29% of racehorses presented for poor performance had cardiac murmurs on physical examination, with mitral regurgitation being the most commonly identified murmur [1]. Nineteen of 348 (5%)

horses had a decreased fractional shortening consistent with preexisting myocardial disease [1]. Exercise-induced arrhythmias have also been identified in racehorses [1,2]. In a retrospective analysis of 80 sport horses presented for poor performance, cardiac disease was identified in 8 (10%) horses. Atrial fibrillation was identified in 6 of these 8 sport horses.

Upper respiratory problems as well as lower respiratory problems can be identified during exercise evaluation. Serial blood gas sampling has been reported to detect dynamic gas changes [16]. In the absence of obvious upper respiratory tract dysfunction, low arterial oxygen tension is suggestive for horses with lower airway disease [16]. Postexercising transendoscopic tracheal samples can also be obtained. Cytologic evaluation can reveal the presence of exercise-induced pulmonary hemorrhage [17]. Hemosiderophages, an extremely sensitive indicator for exercise-induced pulmonary hemorrhage, have been identified in 80% of horses in race training [18]. Other cytologic abnormalities, such as greater than 30% neutrophils, may be indicative of lower airway disease [17].

Treadmill testing can also be beneficial in the identification of a musculoskeletal system lesion. In a retrospective study, 15 of 348 horses were determined to have a significant lameness that was likely the main contributing factor to poor performance [1]. In another retrospective study [2], 25 of 64 horses suspected of respiratory disease also had lameness issues. In another study, 69 of 100 horses with a history of vague poor performance were identified as having a significant lameness issue [2]. In the same study, an additional 111 racehorses presented for inadequate performance with a history of a suspected musculoskeletal system lesion could not be diagnosed without the aid of treadmill testing [2]. Retrospective analysis of 80 sport horses presented for poor performance identified a musculoskeletal system lesion in 3 horses. Other testing for musculoskeletal disease includes creatinine kinase (CK) value evaluation for evidence of exertional rhabdomyolysis. CK levels can also be measured before and after exercise. One study identified 53 horses with subclinical myopathy (serum CK activity >1000 U/L) [1] as a contributing cause for poor performance. None of these horses had clinical signs of exertional rhabdomyolysis during the first 24 hours after strenuous exercise. Even mild elevations in serum CK levels have been associated with an increase in muscle cell membrane permeability [19].

Horses that perform poorly may be affected by multiple problems [1,2]. A combination of several respiratory disorders has been documented [1]. Additionally, multiple systems may be affected. Musculoskeletal problems have been diagnosed in conjunction with respiratory disorders [1,2], and cardiac arrhythmias have been noted in horses with dynamic airway obstruction [1]. Furthermore, horses with suspected respiratory abnormalities have been diagnosed with normal upper airway function but with abnormalities localized to other organ systems [1,2]. On this basis, a complete and comprehensive evaluation is strongly recommended for all

horses presented for poor performance, regardless of whether horses do or do not have a history of abnormal respiratory noise.

Personnel

It requires a well-schooled team of individuals to operate the treadmill and provide adequate testing of the horses. A minimum of four people (two at the head, one at the tail, and one veterinarian operating the endoscope) are required to perform testing safely. At the authors' institution, additional staff are required for complete exercise testing. A cardiologist, an exercise physiologist, and an additional technician (for a total of seven people) are required for complete testing.

Equipment

For the safety of the horse, bell and shin boots are placed on all four limbs. Racing Thoroughbreds are equipped with a halter. Standardbreds are equipped with a harness and bridle. For the sport horse, side reins or a biting rig may be necessary to simulate the head and neck carriage during exercise.

Other methods of measuring upper airway function

A technique has been recently developed to evaluate respiratory noise in exercising horses quantitatively [11]. A unidirectional microphone is placed 4 cm from the horse's nose to obtain a sound recording that can then be assessed using a computer-based spectrogram analysis program. In this study, laryngeal hemiplegia and dorsal displacement of the soft palate were induced using local anesthetic in five Standardbred horses. In horses with laryngeal hemiplegia, expiratory sounds were unaffected. Inspiratory noise demonstrated characteristic frequency bands called formants, which are easily and uniquely identifiable on a spectrogram. In horses with induced dorsal displacement of the soft palate, the noise was characterized by a rattling sound during expiration. Respiratory noise was not present in all horses with induced dorsal displacement of the soft palate, however. The absence of noise has also been noted in naturally occurring dorsal displacement [1,12]. Laryngeal paralysis and dorsal displacement of the soft palate have characteristic sounds and may be determined in this manner [11].

Other qualitative methods have been used for the assessment of upper airway function. They include tidal breathing flow-volume loops, upper airway pressure measurements, and airflow mechanics. Flow-volume loop analysis is a sensitive, noninvasive test. Horses are instrumented with a pneumotachograph mounted in a sealed face mask connected to a computer. Expiratory and inspiratory airflows are obtained by plotting the airflow rate against the volume. This technique has been useful for the

clinical evaluation of lower airway disease [20] and for detecting upper airway obstruction in exercising horses [21]. Horses tested in this fashion may require multiple training sessions to acclimate to galloping with the face mask in place, however, making testing on client horses difficult and cumbersome [8].

Airflow mechanics have mainly been used under controlled research settings. A sealed face mask mounted with a pneumotachograph and mask and tracheal pressures are used to measure airflow and upper airway pressures. Airway resistance can be calculated as a function of airflow and inspiratory and expiratory pressures. Changes in resistance as a result of upper airway obstruction, the effect of surgical management [22], and the effect of the commercially available equine nasal strips [23] have been documented.

The use of upper airway pressure measurements has been reported in clinical and research settings. The repeatability and normal values for measurement of tracheal and pharyngeal pressures have been reported [24]. Using this instrumentation, dorsal displacement of the soft palate was identified as an obstructive disease during the expiratory phase of respiration [25]. Substantial increases in the inspiratory airway pressures of naturally occurring laryngeal hemiplegia and arytenoid chondropathy have been reported [26]. Although quite informative when the pressures are abnormal, normal pressure values do not always rule out respiratory obstruction [8]. Although the above-mentioned methods may be useful under certain conditions, exercising videoendoscopy remains the mainstay for the diagnosis of upper airway dysfunction.

Upper respiratory abnormalities observed

Laryngeal hemiplegia

Grade IV laryngeal hemiplegia can be easily diagnosed with videoendoscopy at rest [9]. Grade III laryngeal hemiparesis cases often require exercising evaluation to assess the dynamic function [9,10]. Approximately 77% of racehorses affected with grade III left laryngeal hemiparesis do have significant dynamic collapse of the left arytenoid and vocal fold during exercise [10]. Surgical intervention remains the treatment of choice.

In sport horses, partial and complete paralysis of an arytenoid can affect performance. The magnitude of the effect varies with each horse and its level of competition. For example, a show jumper with grade IV left laryngeal hemiplegia may compete successfully as a children's jumper, jumping without difficulty over 3-ft 6-in fences, yet be unable to complete a Grand Prix course. Dressage horses may compete with laryngeal hemiplegia at lower levels; however, as the degree of difficulty and collection required for the upper-level movements increases, laryngeal obstruction can hinder performance.

After laryngoplasty

High-speed treadmill testing may also be useful for evaluation of the upper airway after surgery. During exercise, videoendoscopic evaluation of the upper airway may be critical for assessment of upper respiratory dysfunction from which appropriate treatment recommendations can be made [1]. Only exercising evaluation can provide a true assessment of the laryngeal dysfunction. For example, when evaluating a horse with a previous laryngoplasty that is making a loud upper respiratory noise, some horses may have complete failure of the laryngoplasty, whereas others may have dynamic collapse of other laryngeal tissues or pharyngeal dysfunction. Obviously, in these cases, dynamic assessment is critical for proper treatment recommendations.

Dorsal displacement of the soft palate

Dorsal displacement of the soft palate is the most common pharyngeal dysfunction in racing horses. Additionally, as many 30% of horses do not make a respiratory noise during displacement, making diagnosis difficult [27]. Sport horses may also be hindered with dorsal displacement of the soft palate. Retrospective analysis of 80 sport horses presented for poor performance identified the disease affecting 6 horses. The exact etiology of this disease is unknown. Therefore, there are many surgical options with varying success rates. Surgical intervention is usually recommended when conservative treatments like a tongue-tie, a figure-of-eight nose band, or anti-inflammatory throat sprays have been unsuccessful.

Pharyngeal collapse

Pharyngeal collapse can only be identified during exercise [1,4,12]. Pharyngeal collapse can be classified as dorsal, lateral, or circumferential. Severely affected horses may be compromised and usually make a “roar-like” noise. These characteristics of the disease often require high-speed treadmill testing for accurate diagnosis. This disease has been identified in racehorses [1,4,12] and sport horses. Elevated head and neck carriage can further impair this disease. Conservative management with long-term rest and anti-inflammatories can be successful in young immature horses; however, it can have a limited effect on older horses. Because sport horses are often aged, pharyngeal collapse can be a devastating disease.

Axial deviation of the aryepiglottic folds

Diagnosis of deviation of the aryepiglottic folds can only be made by videoendoscopic evaluation of an exercising horse [1,4,12,13]. The disease manifests with varying degrees of collapse [12,13]. One or both of the folds may be affected, and the disease may be noted in conjunction with other

upper respiratory diseases [1,13]. Severely affected horses do benefit from surgical resection [13].

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