Value of High-Speed Treadmill Endoscopy

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High-speed treadmill endoscopy is an important diagnostic procedure for determining dynamic causes of upper respiratory obstruction. While some abnormalities may be recognized during resting endoscopy, there are others such as axial deviation of the aryepiglottic folds, pharyngeal collapse, and epiglottic retroversion that cannot be identified during resting endoscopy. Author’s address: Dept. of Clinical Studies, New Bolton Center, University of Pennsylvania, 382 W. Street Rd., Kennett Square, PA 19348. © 1998 AAEP.

1. Introduction
High-speed treadmill (HSTM) endoscopy has been an invaluable tool for determining causes of poor performance and abnormal upper respiratory noise in athletic horses. While gross structural abnormalities can be diagnosed by resting endoscopy and other methods, it is the dynamic abnormalities that take place during strenuous exercise that cannot be appreciated by any other method but treadmill endoscopy. Since the dynamics of airflow change so dramatically between the resting and exercising horse, the upper airway must also change accordingly to meet those demands. The equine athlete, under maximal exertion, increases its airflow by almost 20-fold relative to the resting animal, and it creates negative pressures within the airway 9-fold greater than the resting animal. At times the airway cannot meet the demands of the increased stress, just as other physiologic systems fail under increased levels of stress. The areas of failure can frequently be determined with treadmill endoscopy.

2. Testing
High-speed treadmill endoscopy is most useful for the racehorses because they experience the greatest demands on the respiratory tract, but it has also been used successfully for ponies, draft horses, and all breeds of performance or sport horses. The test employed is extremely important in obtaining accurate results. A more comprehensive treadmill test, including metabolic and cardiac evaluations, should always be performed if there is any possibility of a non-upper respiratory problem existing. An experienced, well-qualified team is essential during HSTM examinations for both the safety of the animal and the safety of the individuals carrying out the test. The test used at the New Bolton Center for racehorses is as follows.

1. Warm up through a combination of walk, trot, and canter for 2000 m.
2. Walk again until the heart rate reaches 80–90 beats/min; stop and pass the endoscope.
3. Accelerate to 9 m/s (incline treadmill to 3° for Thoroughbreds).
4. Accelerate to 11 m/s for 400 m.
5. Accelerate to 12 m/s for 400 m.
6. Accelerate to 14 m/s for 1600 m.
7. Decelerate to 12 m/s for 400 m.
Obviously the speed may need to be altered if the horse cannot maintain position on the treadmill. The horse must also be racing fit at the time of the examination. If the horse has been taken out of work because of a suspected problem and then examined on the treadmill, the likelihood of finding the true problem dramatically diminishes. A horse out of work may be too unfit to withstand a maximal exertional effort on the treadmill, and the problem may not manifest itself. Also, the unfit horse is at greater risk of injury. Trainers and owners must consider a treadmill examination like an upcoming event or race, with some of the risks that accompany that high level of exercise. In most instances, the schooling session and the test can all be performed in one day, on an outpatient basis.

Laryngeal hemiplegia and dorsal displacement of the soft palate (DDSP) have been problems recognized for many years, but HSTM endoscopy has enabled us to determine which horses need to be treated for laryngeal hemiplegia, and it has provided some insight into treatment success rates. It has also shown us that dorsal displacement of the soft palate occurs for many different reasons and requires treatment commensurate with the cause. Other disorders such as pharyngeal collapse, axial deviation of the aryepiglottic folds, and epiglottic retroversion are disorders that were not diagnosed until HSTM endoscopy was employed. While many practitioners have limited access to making these diagnoses with treadmill endoscopy, it is important to recognize these abnormalities that can be diagnosed and include them in the list of differential diagnoses before a management plan is determined.

### 3. Abnormalities

#### A. Laryngeal Hemiplegia

The grading system of laryngeal hemiplegia (Fig. 1) previously established by Hackett et al. is valuable in estimating which horses are experiencing upper airway obstructions, but it is not conclusive. Treadmill endoscopy, with the horse performing a workload equivalent to a normal performance, is required to be conclusive. It is well recognized that approximately 80% of racehorses demonstrating a grade 3 left laryngeal hemiplegia will have a significant dynamic collapse of the arytenoid during strenuous exercise. Under their performance conditions, show horses with a grade 3 hemiplegia may not reach a level of dynamic collapse, and those that do may still be able to compete effectively, mitigating the need for surgery. Grade 3 hemiplegia is judged by the degree of abduction after nasal occlusion or immediately after swallowing. Judging the degree of abduction during nasal occlusion affords the examiner more time to make an assessment, but a slightly smaller percentage of grade 3 horses have significant

![Fig. 1. Endoscopic view of a laryngeal hemiplegic (grade 3) horse (a) at rest and (b) at rest, after swallowing. (c) and (d) show the progressive dynamic collapse of the left arytenoid during HSTM endoscopy.](image-url)
Dynamic collapse at speed with this technique versus assessment after swallowing. With any hemiplegic horse, palpation of the cricoarytenoideus muscle should be performed. There is a fairly good correlation between arytenoid collapse for the grade 3 hemiplegics and significant muscular atrophy. Head and neck flexion may also affect upper airway function. The degree of flexion should be simulated during HSTM endoscopy if there are no abnormalities with the head in a free position, and if there is a strong history of upper respiratory noise.

B. Dorsal Displacement of the Soft Palate

DDSP is an extremely difficult problem to confirm. Nasal occlusion can create negative pressures within the pharynx that approximate the pressures during exercise, and horses at rest that displace easily during nasal occlusion are more likely to displace at high-speed exercise. However, many horses that displace during nasal occlusion are normal at high speed. Also, the pharyngeal collapse that often occurs during nasal occlusion does not typically occur during high-speed exercise. To complicate matters further, most horses do not make a loud expiratory noise when they first displace their palates. In a recent evaluation of horses that had a history of poor performance and that displaced their palates during a HSTM examination, almost half had no history of an abnormal respiratory noise during racing. Furthermore, only 6/81 and 10/81 had an ulcerated palate, or an abnormal epiglottis, respectively. All of these factors combined with the intermittent nature of the disease make it an elusive diagnosis and a difficult problem to treat effectively. There is good recent evidence supporting a neurogenic cause of DDSP, but from a subjective clinical assessment, DDSP appears to be multifactorial in pathogenesis, and therefore will likely be multiple different treatments required to correct the problem.

Fig. 2. Axial deviation of the aryepiglottic folds during treadmill endoscopy.

Fig. 3. Inspiratory cycle of epiglottic retroversion: (a) just prior to inspiration, (b) midinspiration, (c) beginning of expiration, (d) expiration.
C. Axial Deviation of the Aryepiglottic Folds and Pharyngeal Collapse

Both axial deviation of the aryepiglottic folds and pharyngeal collapse (Fig. 2) are assumed to be neuromuscular dysfunctions that worsen with fatigue and are only evident during high-speed treadmill endoscopy. Both abnormalities may precipitate DDSP or create a respiratory obstruction without DDSP. If on resting endoscopy a horse is unable to replace its palate easily or leaves it displaced for an extended period of time, one of these types of pharyngeal dysfunction is more likely. When the endoscope is placed through the larynx into the trachea, most horses will displace their palate, but they quickly replace it when the endoscope returns to the pharynx. Conservative management, consisting of turnout and a tapering dose of oral steroids, has met with some success for young horses with either abnormality. Laser resection of the aryepiglottic folds has been employed with success for horses with an axial deviation of the aryepiglottic folds.2

D. Epiglottic Retroversion

Epiglottic retroversion (Fig. 3) is a rare condition in which there is no definitive abnormality noted on resting endoscopic examination. A close observer may notice a small area of the oropharyngeal mucosa above the free edge of the palate in some cases. While the epiglottis can retrovert 180° into the lumen of the larynx during inspiration at high speed, this abnormality cannot be reproduced at rest even with nasal occlusion. The history of a gurgling, inspiratory noise is heard during exercise and should prompt the clinician to pursue high-speed treadmill endoscopy.

4. Conclusions

While the resting endoscopic examination of the upper respiratory tract has great value, there are significant limitations in the evaluation of dynamic problems, and it is just one component of the evaluation that must be in agreement with all the other components to arrive at a definitive diagnosis. Our ability to predict high-speed abnormalities based on resting endoscopic examination is dependent upon the experience of the examiner, the quality of the endoscopic equipment, the thoroughness of the examination, and an accurate history. Laryngeal and pharyngeal function should be assessed at rest, after swallowing, and after nasal occlusion. Furthermore, a single disorder apparent on resting endoscopic examination should not be presumed to be the entire cause of the performance problem if the history is not supportive. Multiple abnormalities often exist.

References and Footnotes
