Abnormalities of the pharynx and larynx are associated with poor performance in racehorses. In an effort to avoid purchase of Thoroughbreds with aberrations of the URT (ie, nasal passages, pharynx, and larynx), veterinarians are routinely requested to evaluate potential racehorses offered at public auction. This is accomplished primarily through an external visual assessment and an internal endoscopic examination, which provides anatomic and functional information on the URT. The structures of the URT, particularly the larynx and pharynx, are closely scrutinized for evidence of pathological abnormalities known to adversely affect airflow. The results of this brief examination in horses at rest can be used by veterinarians and potential buyers to assess the possible effects of structural or dynamic URT abnormalities on the future athletic performance of a horse. The interpretation of examination findings can substantially affect the purchase price of horses at auction.

In a study of 816 Thoroughbred yearlings, investigators found an association between a diagnosis of grade III AF and a decrease in the number of starts and amount of earnings at 3 years of age; grade II or III ES was associated with fewer starts and less earnings at 2 years of age. Another study of 427 Thoroughbred yearlings revealed that horses with grade III AF had a decrease in racing performance, but horses with ES abnormalities did not.

The purpose of the study reported here was to compare the results of endoscopic evaluation of the larynx in a large number of Thoroughbred yearlings with racing performance at 2, 3, and 4 years of age. We hypothesized that horses with grades III or IV AF or grades II to IV ES would have fewer starts per year, less total earnings per year, and less mean earnings per start, compared with the results for horses with grade I or II AF or horses with grade 0 or I ES, respectively.

**Materials and Methods**

**Case selection**—Medical records of Rood and Riddle Equine Hospital from 1998 through 2001 were searched to
identify Thoroughbred yearlings offered at public auction that were examined for URT defects via endoscopy. Yearlings were examined at the request of potential buyers. All examinations were performed by 1 veterinarian (SWP).

Medical records review—Medical records were evaluated for information pertaining to the results of endoscopic examination. The unsedated yearlings were restrained in a stall, usually by the use of a nose twitch, although a lip chain was used in some instances. The endoscope was passed through the right nostril to the level of the nasopharynx. Arytenoid function was visually assessed in horses at rest, during nasal occlusion, and after swallowing. The character of the epiglottis was also observed and recorded.

AF and ES scoring—Arytenoid function was initially graded by use of a modified scale of I to IV. Those grades were later retrofitted into a modified Havemeyer grading scale to standardize grading scores. Briefly, the Havemeyer scale is as follows: grade I, synchronous and symmetric arytenoid movement with full abduction achieved and maintained; grade II.1, transient asynchronous or asymmetric arytenoid movement with maximal abduction achieved and maintained; grade II.2, asynchronous or asymmetric arytenoid movement with maximal abduction achieved and maintained at times; grade III, asynchronous or asymmetric arytenoid movement with full abduction not achieved or not maintained; and grade IV, no arytenoid movement. The Havemeyer scale subdivides grade III into 3 subcategories, but the subcategories were not used in this study because there were too few yearlings that qualified for the subcategories.

Epiglottic structure was graded from 0 to IV (Figure 1). The ES grades were assigned as follows: grade I = slightly thin with adequate length and texture, slightly flaccid, and without serrated edges; grade II = thinner than the typical structure, of adequate length, and mildly flaccid with curled edges and no obvious vasculature on the dorsal aspect; grade III = extremely thin with adequate length, moderately flaccid, and could be easily bent; and grade IV = extremely thin, markedly short, severely flaccid, and could be easily bent. The record was also annotated if a short or narrow epiglottis was detected in any yearling that would otherwise have an ES grade of 0.

Performance data—For each horse, the number of starts per year, total earnings per year, and mean earnings per start at 2, 3, and 4 years of age were obtained from race records from an online Jockey Club database. Sales prices were obtained from online databases maintained by the sales companies.

Statistical analysis—All response variables were evaluated by use of a 2-way ANOVA with equal variance and a 1-way ANOVA with unequal variances followed by the protected least significant difference method of pairwise comparisons. All earnings variables were transformed to the logarithms of (values + 1) because the data were highly positively skewed. Values of \( P < 0.05 \) were accepted as significant.

Initial analysis of the response variables via 2-way ANOVA with AF and ES as factors revealed few significant differences. However, the equal variance assumption was violated, which resulted in low power for the 2-way ANOVA. Use of the 2-way ANOVA identified 3 horses that had high grades of both AF (II.2 or III) and ES (III to IV). Those horses were removed from further analyses prior to assessment by use of a 1-way ANOVA. The results for remaining horses were compared via unequal variance 1-way ANOVA, and when significant results were obtained, pairwise differences for AF and ES were examined separately. All statistical analysis was performed by use of a proprietary software package.

Results

The records of 2,954 horses met the criteria for inclusion in the study. Mean number of starts per year, mean total earnings per year, and mean earnings per start were determined for horses of each grade of AF (Table 1) and ES (Table 2). No significant differences were detected for any of the variables when grade I and II.1 AF were compared. Thus, results for horses that had grade I or II.1 AF were combined for further evaluation, and comparisons were performed between this combined category; grade II.2 AF; and grade III AF (Table 3).

When results for horses with grade II.2 AF were compared with results for horses in the grade I or II.1...
When the data were analyzed to compare the results for horses with grade I or II.1 AF with results for grade III AF horses, those with grade III AF had significantly fewer starts, less mean total earnings per year, and less mean earnings per start at 3 and 4 years of age than did horses with grade I or II.1 AF. There was no significant difference in any variable at 2 years of age. However, 1 horse with grade III AF had much higher earnings ($366,000) than did any other grade III AF horse as a 2 year old, and that horse did not race at 3 or 4 years of age. When this outlier was excluded from the analysis, horses with grade III AF had significantly lower values for mean number of starts, mean total earnings per year, and mean earnings per start at 2 years of age as well.

Results for horses with grade II.2 AF were compared with results for horses with grade III AF. Horses with grade III AF had significantly lower values for mean number of starts, mean total earnings per year, and mean earnings per start at 3 years of age, with significantly fewer starts and less mean total earnings per year at 4 years of age. Although the mean earnings per start was less among horses with grade III AF than in horses with grade II.2 AF at 4 years of age, these values did not differ significantly ($P = 0.083$). There was no significant difference for any variable at 2 years of age, but when the previously mentioned grade III outlier was excluded from the analysis, horses with grade III AF had significantly less mean total earnings per year and mean earnings per start at 2 years of age.

No significant differences were detected between variables for horses with grades 0, 1, and II ES, so the 3 categories were combined to investigate the effect of ES on racing performance. Grade III and IV ES were combined because only 2 horses had a grade IV ES (Table 4). When results for the grade 0 to II ES group were compared with results for the grade III and IV ES group, horses in the latter category had significantly less mean total earnings per year and mean earnings per start at 2 and 4 years of age. Although the mean total earnings per year and mean earnings per start were less at 3 years of age for horses with grade III or IV ES than for horses with grade 0 to II, the differences were not significant. No difference was detected in the number of starts between any age.

No differences were found when the results for horses with a narrow epiglottis were compared with the results for horses with a typical grade 0 ES, so results for the 2 groups were combined for analysis and compared with results for horses that had a short epiglottis (Table 3). Horses with a short epiglottis had significantly less mean total earnings per year and significantly less mean earnings per start at 3 years of age. Although the mean earnings per start was less for the horses with a short epiglottis at 4 years of age, these values were not significantly different.
Further comparisons were performed between each combination of AF and ES grades. However, no additional significant differences were found for any of the response variables.

Discussion

The study reported here adds new information to that provided by other studies; it included a large number of horses and analysis of race records through their fourth year of age, as opposed to results for years 2 and 3 only. Our findings are in agreement with the results of other studies, wherein decreased racing performance was described in horses that had grade III AF as yearlings, compared with horses that had AF grades of I, II.1, or II.2. In the present study, horses with grade II.2 AF also had significantly less earnings at 4 years of age, compared with earnings for horses that had grade I or II.1 AF. Although results were not significantly different at 2 and 3 years of age, horses with grade II.2 AF had less earnings, compared with earnings for horses that had grade I or II.1 AF.

The findings reported here suggest that yearlings with grade II.2 AF may have a decrease in earning potential. This should cause veterinarians to be cautious in their assessment of a yearling Thoroughbred with grade II.2 AF. It is also possible that some of the horses with grade II.2 AF as yearlings deteriorated over time to grade III AF, which would account for the significant difference in earnings measures detected at 4 years of age but not at 2 and 3 years of age. Our finding of less earnings for horses with grade III or IV ES abnormalities or a short epiglottis is in contrast with the results of a study in which investigators found no effect of ES on racing performance, although the epiglottis was categorized only as normal or abnormal in those evaluations, and the subjective categorization was determined by 4 different veterinarians. In another study, our group found an effect on mean earnings per start at 2 years of age among horses with grade II or III ES, but no effect was observed at 3 years of age and those horses were not followed through their fourth year of age. In the current study, the detection of decreased performance in horses with grade III or IV ES at 2 and 4 years of age or a short epiglottis at 2 and 3 years of age may be attributable to the larger number of horses examined because severe epiglottic abnormalities are an infrequent (1%) phenomenon (Table 2). The use of a consistently applied (ie, by 1 veterinarian) and defined grading scale to categorize epiglottic abnormalities may also have contributed to this difference. Although the results were not significantly different, the earnings values for horses with grades 0 to II ES were greater than those for horses with grade III or IV ES at 3 years of age. Yearlings appeared to be able to tolerate mild to moderate abnormalities of the ES without adverse effects on racing performance, but more severe abnormalities may impact athletic potential. The specific mechanism by which epiglottic abnormalities cause poor performance is speculative and was not examined in the study reported here.

Although the use of restraint can alter the appearance of the URT, we attempted to control for this variable by the use of a consistent method of restraint for the horses. Almost all of the yearlings examined in this study were restrained by use of a nose twitch, and a lip chain was used to restrain the remaining horses. In the authors' experience and opinion, the benefits gained by restraining a horse to prevent agitation (which may have negative effects on the appearance of the URT) outweigh the potential drawback that the restraint method may have a negative effect on the outcome of the examination.

All of the examinations in the present study were performed by 1 experienced veterinarian (SWP) to decrease interobserver variability in grading endoscopic findings. The frequency of each AF and ES grade in the study reported here was within 1 percentage point of the grade frequency observed in another study of sales yearlings by our group in which the same individual was the observer; this suggests that the intraobserver consistency was high. The present study included only yearlings offered for sale at a public auction, so the frequency of abnormalities was not reflective of the general yearling Thoroughbred population. Yearlings with URT abnormalities listed as returnable in the sales catalogues are usually identified prior to the sale and are subsequently not offered at the sale.

It was not determined whether any of the horses had undergone surgery of the URT during their racing careers. We suspected that some horses had URT surgery, which may have positively or negatively affected their racing performance. Without surgical intervention, there may have been additional significant differences between the AF and ES groups. It is important to mention that this analysis was performed on the mean values for a large group of horses. There are multiple factors that contribute to a successful

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| Table 4—Results of evaluation of racing performance indicators for Thoroughbreds categorized on the basis of the combined ES grade group as yearlings and age at the time of racing. |
|---|---|---|---|---|
| | ES grade | No. (%) | Age (y) | Total earnings ($| | Earnings/ start ($| |
| | of horses* | of starts† | | | | |
| 0–II | 2,924 (99) | 2 | 1.49 | 11,428‡ | 3,041† |
| | | 3 | 4.76 | 31,715 | 4,379 |
| | | 4 | 4.10 | 23,181† | 3,053† |
| III–IV | 27 (1) | 2 | 1.74 | 5,103‡ | 1,243‡ |
| | | 3 | 4.26 | 21,486 | 3,298 |
| | | 4 | 3.74 | 11,055‡ | 1,338‡ |

†Values differ significantly (P < 0.05) for horses that had grade III or IV ES, compared with horses of the corresponding age group that had grade II, I, or II ES. See Table 1 for remainder of key.

| Table 5—Results of analysis of racing performance indicators for Thoroughbreds categorized on the basis of epiglottis length as yearlings and age at time of racing. |
|---|---|---|---|---|
| Epiglottis length | No. (%) | Age (y) | Total earnings ($| | Earnings/ start ($| |
| | of horses* | of starts† | | | | |
| Anatomically normal | 2,936 (99) | 2 | 1.50 | 11,431§ | 3,030 |
| | | 3 | 4.76 | 31,722§ | 4,980§ |
| | | 4 | 4.09 | 23,099 | 3,940 |
| Short | 15 (1) | 2 | 1.20 | 4,845‡ | 1,945‡ |
| | | 3 | 3.55 | 11,961 | 1,762 |
| | | 4 | 5.20 | 17,310 | 1,864 |

†Values differ significantly (P < 0.05) for horses that had a short epiglottis, compared with values for horses of the corresponding age group that had an anatomically normal epiglottis. See Table 1 for remainder of key.
racing career, and some of these may be unquantifiable. In the present study, only AF and ES were examined, and many other conditions, including other abnormalities of the URT, can affect racing performance.

Veterinarians must be mindful that physical and endoscopic examination of a resting horse does not take into account the changes that develop during exercise. Additionally, there are many horses that race successfully with URT abnormalities. Further investigations that are needed include comparison of the results of endoscopic examination in resting horses with the results of endoscopic examination during exercise, correlation of URT evaluation at 2 years of age with racing performance, and further assessment of the effects of grade II.2 AF, grades III and IV ES, and a short epiglottis on racing performance.

Yearling horses with grade I or II.1 AF or grade 0 to II ES can be considered to have similar athletic potential in regard to their URT, provided no other abnormalities are detected. Our results suggested that yearling horses with grade III AF or grade III or IV ES had a decrease in racing potential. Yearling horses with grade II.2 AF or a short epiglottis also typically had a decrease in racing performance.

References

From this month’s AJVR

**Effect of semen in urine specimens on urine protein concentration determined by means of dipstick analysis**

Laurie G. Prober et al

**Objective**—To determine the effect of semen in urine specimens on urine protein concentration measured by means of dipstick analysis.

**Sample Population**—14 urine samples from 3 adult castrated male dogs and 14 semen samples from 7 adult sexually intact male dogs.

**Procedures**—Serial dilutions of the whole ejaculate or spermatozoa-free seminal fluid in urine were created, and unaltered and diluted urine samples were analyzed by means of a commercially available dipstick; pH and specific gravity of the samples were also measured. Spermatozoa and WBC counts of the semen samples and protein concentration of the seminal fluid were determined.

**Results**—Protein concentrations determined by means of dipstick analysis of urine specimens to which whole ejaculate (dilutions of 1:1, 1:2, 1:16, and 1:64, and 1:256) or seminal fluid (dilutions of 1:1, 1:2, 1:16, and 1:64) had been added were significantly higher than concentrations in unaltered urine samples. All 13 samples to which whole ejaculate was added at a dilution of 1:2 and 10 of 12 samples to which seminal fluid was added at a dilution of 1:2 were positive for blood on dipstick analysis. There was no significant linear correlation between spermatoza or WBC count of the semen sample and protein concentration of the spermatozoa-free seminal fluid.

**Conclusions and Clinical Relevance**—Results suggested that regardless of whether spermatozoa were present, semen contamination could result in false-positive results for protein and blood during dipstick analysis of urine samples from sexually intact male dogs. (Am J Vet Res 2010;71:298–292)