Correlation of performance with endoscopic and radiographic assessment of epiglottic hypoplasia in racehorses with epiglottic entrapment corrected by use of contact neodymium:yttrium aluminum garnet laser

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Summary: Epiglottic entrapment in 35 Thoroughbred and 44 Standardbred horses was corrected transendoscopically by use of a neodymium:yttrium aluminum garnet laser. Before surgery, the entrapped epiglottis was classified as hypoplastic or normal in each horse on the basis of endoscopic appearance alone. Using a digitizer, thyroepiglottic length was determined from lateral-view laryngeal radiographs. For 78 racehorses, earnings (<$5,000 or >$5,000) were compared before and after surgery. Earnings category and racing performance after surgery were tested for association with endoscopically determined epiglottic hypoplasia and radiographically determined thyroepiglottic length.

Endoscopy and radiography were useful methods of evaluating the epiglottis in horses with epiglottic entrapment. Mean (±SD) thyroepiglottic length for both breeds of horses with epiglottic entrapment was significantly (P = 0.0001) smaller (Thoroughbreds, 7.28 ± 0.67 cm; Standardbreds, 7.21 ± 0.62 cm), compared with thyroepiglottic length measured from control groups composed of clinically normal Thoroughbreds (8.56 ± 0.29 cm) and Standardbreds (8.74 ± 0.38 cm) racehorses. Both breeds of horses with epiglottic entrapment that had endoscopically apparent hypoplastic epiglottis had significantly (P < 0.0001) smaller thyroepiglottic length (Thoroughbreds, 6.64 ± 0.60 cm; Standardbreds, 6.93 ± 0.72 cm) than did horses with epiglottic entrapment that had endoscopically normal epiglottis (Thoroughbreds, 7.57 ± 0.47 cm, Standardbreds, 7.36 ± 0.50 cm). Significant difference was not detected in endoscopic appearance of the epiglottis among age, gender, or breed distributions.

For either breed, earnings and performance were not significantly associated with endoscopically determined epiglottic hypoplasia or radiographically determined thyroepiglottic length. Prognosis for racing performance after laser correction of epiglottic entrapment should be based on assessment of the endoscopic and radiographic appearances of the epiglottis, pharynx, and larynx, determination of thyroepiglottic length, and a knowledge of the horse's earnings and racing performance prior to surgery.

Epiglottic entrapment usually causes respiratory distress, noise, or exercise intolerance, or both, particularly in Thoroughbred and Standardbred racehorses.1-3 In an earlier retrospective study,1 epiglottic entrapment was associated with epiglottic hypoplasia on the basis of endoscopic and surgical findings. More recently, a technique for laryngeal radiography (lateral view) has been described that allows for accurate measurement of thyroepiglottic length in standing horses;4 9 Thoroughbred racehorses with epiglottic entrapment and 6 with dorsal displacement of the soft palate had significantly shorter mean ± SD thyroepiglottic length (6.59 ± 0.33 and 6.43 ± 0.40 cm, respectively), compared with thyroepiglottic length in 24 clinically normal Thoroughbred horses (8.76 ± 0.44 cm). To the author's knowledge, thyroepiglottic length in clinically normal Standardbred racehorses or in a large group of Standardbred racehorses with epiglottic entrapment has not been examined to see whether Standardbreds with entrapment also have hypoplastic epiglottis. It may be important to determine epiglottic size prior to correction of epiglottic entrapment, because horses with epiglottic hypoplasia reportedly have poor prognosis for successful racing careers.1,2,4-10

The purposes of the study reported here were to compare thyroepiglottic length in 35 Thoroughbred and 44 Standardbred horses with epiglottic entrapment with thyroepiglottic length in a group of endoscopically normal Thoroughbred and Standardbred racehorses, to compare thyroepiglottic length in Thoroughbred and Standardbred horses with epiglottic entrapment and endoscopically apparent hypoplastic epiglottis with thyroepiglottic length in Thoroughbred and Standardbred horses with epiglottic entrapment and endoscopically...
normal-appearing epiglottis, and to correlate endoscopic and radiographic assessments of epiglottic size and appearance with earnings and performance after contact neodymium yttrium aluminum garnet (Nd:YAG) laser correction of epiglottic entrapment.

Materials and Methods

Horses—During the 19-month period of the study (Mar 31, 1987 to Nov 4, 1988), 81 horses were referred to the author at New Bolton Center, University of Pennsylvania, for laser correction of epiglottic entrapment. Two horses were excluded from the study because lateral-view laryngeal radiograph could not be obtained.

Endoscopy—All horses were examined by use of a flexible fiberoptic endoscope introduced into the right nasal passage. Horses were not sedated, but were restrained in a stock by use of a rope nose.
twitch, then were examined. The entrapped epiglottis was classified by the author as normal or hypoplastic solely on the basis of endoscopic appearance, before performing laryngeal radiography¹ (Fig 1 and 2). The hypoplastic epiglottis appeared abnormally short or narrow or thin, or had a deformed contour or axis within the entrapping membranes. In some horses in which the epiglottis was severely hypoplastic, all these abnormal characteristics were observed.

Laser correction—Preoperative lateral laryngeal radiography¹ was performed with horses sedated by iv administration of 0.44 mg of xylazine/kg of body weight (Fig 3 and 4). Immediately after obtaining radiographs, contact Nd:YAG laser correction of epiglottic entrapment was performed.³ Laryngeal radiography (lateral view) was also performed on 17 healthy Thoroughbred and 8 healthy Standardbred racehorses with endoscopically normal-appearing upper airways; these horses had been referred for reasons other than upper airway obstruction. None of the control horses had a history of respiratory tract noise or was believed to have exercise intolerance caused by upper airway obstruction. Thyroepiglottic length was measured, using a digitizer.⁴,⁵

Follow-up evaluation and assessment of performance—Follow-up evaluation, which ranged from 2 to 23 months after laser surgery (mean, 11 months), was obtained by telephone conversation with owners, trainers, and referring veterinarians, and by examination of race lines.⁶,⁷

To distinguish between horses with differing athletic ability, each horse making at least 3 racing starts before and after surgery was categorized on the basis of earnings (<$5,000 or >$5,000) for starts made the year before surgery and again after surgery.

For racehorses making at least 3 starts performance was assessed by evaluating finish position (first, second, or third), race times for the race distances, class of race, and race track for all starts made the year before and the year after surgery, Earnings and performance were classified into the following categories: improved over the previous year's performance; no change from the previous year's performance; and decreased from the previous year's performance.

Statistical methods—The relationship between epiglottic length and age in the control horses was evaluated, using the correlation coefficient. The effects of breed and entrapment on epiglottic length were evaluated. Using analysis of variance and controlling for breed, epiglottic length in horses with and without endoscopically apparent epiglottic hypoplasia was compared among groups of horses with entrapment. Earnings category before surgery was compared with earnings category after surgery, using the McNemar test. Performance in horses with entrapment was tested for association with hypoplasia, using the χ² test. Tests for association with earnings and performance were performed separately by breed. Epiglottic length was compared among breeds and performance categories, using analysis of variance. Significance value of 0.05 was used for all statistical tests.¹¹

Results

Epiglottic entrapment in 44 Standardbreds and 34 Thoroughbred racehorses and 1 Thoroughbred polo mare was treated by transendoscopic axial division, using a contact nd:YAG laser. Significant difference was not detected in age or gender distribution by breed or endoscopic appearance of the epiglottis (no entrapment [controls], no entrapment and hypoplastic, entrapment and normal-appearing; Table 1).

Epiglottic length correlated with endoscopic appearance—In clinically normal control horses, age did not correlate to thyroepiglottic length. Mean thyroepiglottic length differed significantly (P = 0.0001) between control horses and horses with entrapment, but difference between breeds was not evident. Within the groups of Thoroughbreds and Standardbreds with entrapment, those with endoscopically apparent hypoplasia had a significantly (P < 0.0001) smaller mean thyroepi-
Table 1—Thyroepiglottic length measured from lateral-view laryngeal radiographs of Thoroughbred and Standardbred racehorses

<table>
<thead>
<tr>
<th>Endoscopic epiglottic appearance</th>
<th>Breed</th>
<th>No. of horses</th>
<th>Age (yr)</th>
<th>Gender</th>
<th>Thyroepiglottic length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No entrapment, normal appearance</td>
<td>TB</td>
<td>17</td>
<td>9.2 ± 0.1</td>
<td>8.6 ± 0.1</td>
<td>2.8 ± 0.1</td>
</tr>
<tr>
<td></td>
<td>STD</td>
<td>8</td>
<td>4.1 ± 0.1</td>
<td>4.1 ± 0.1</td>
<td>0.8 ± 0.1</td>
</tr>
<tr>
<td>Entrapment</td>
<td>TB</td>
<td>11</td>
<td>2.9 ± 0.1</td>
<td>2.9 ± 0.1</td>
<td>2.9 ± 0.1</td>
</tr>
<tr>
<td>Hypoplastic</td>
<td>STD</td>
<td>16</td>
<td>2.9 ± 0.1</td>
<td>2.9 ± 0.1</td>
<td>2.9 ± 0.1</td>
</tr>
<tr>
<td>Normal</td>
<td>TB</td>
<td>24</td>
<td>11 ± 0.1</td>
<td>11 ± 0.1</td>
<td>11 ± 0.1</td>
</tr>
<tr>
<td></td>
<td>STD</td>
<td>28</td>
<td>6.7 ± 0.1</td>
<td>6.7 ± 0.1</td>
<td>6.7 ± 0.1</td>
</tr>
<tr>
<td>Total</td>
<td>TB</td>
<td>35</td>
<td>16 ± 0.1</td>
<td>16 ± 0.1</td>
<td>16 ± 0.1</td>
</tr>
<tr>
<td></td>
<td>STD</td>
<td>44</td>
<td>8.9 ± 0.1</td>
<td>8.9 ± 0.1</td>
<td>8.9 ± 0.1</td>
</tr>
</tbody>
</table>

*Significantly (P < 0.0001) less than value in horses without entrapment but with endoscopically apparent hypoplasia. *Significantly (P = 0.0001) less than value in horses without entrapment and normal epiglottic length. **Total no. with entrapment.

TB = Thoroughbred; STD = Standardbred; F = female; D = gelding; M = male.

Measurements were made using a digitizer and corrected individually for radiographic magnification. Data are expressed as mean ± SE.

glottic length than did those that had normal endoscopic appearance.

In the control group of 17 endoscopically normal Thoroughbred racehorses, mean thyroepiglottic length was 8.36 ± 0.29 cm (range, 8.13 to 9.21 cm). Thirty-five Thoroughbred horses with epiglottic entrapment had mean thyroepiglottic length of 7.28 ± 0.67 cm (range, 5.65 to 8.64 cm).

Among the group of 35 Thoroughbreds with entrapment, 24 (69%) had endoscopically normal-appearing epiglottis, and mean thyroepiglottic length was 7.27 ± 0.75 cm (range, 6.73 to 8.64 cm). In the other 11 Thoroughbred horses (31%) that had hypoplastic epiglottis confirmed by endoscopy, the mean thyroepiglottic length was 6.64 ± 0.60 cm (range, 5.65 to 7.55 cm).

In the control group of 8 endoscopically normal Standardbred racehorses, mean thyroepiglottic length was 8.74 ± 0.38 cm (range, 8.23 to 9.21 cm).
cm). Forty-four Standardbred racehorses with epiglottic entrapment had thyroepiglottic length of 7.21 ± 0.62 cm (range, 5.68 to 8.32 cm).

Among the group of 44 Standardbred with entrapment, 28 (64%) had an endoscopically normal-appearing epiglottis, and mean thyroepiglottic length was 7.36 ± 0.50 cm (range, 6.43 to 8.27). In the other 16 horses (36%) that had hypoplastic epiglottis determined by endoscopy, mean thyroepiglottic length was 6.93 ± 0.72 (range, 5.68 to 8.32).

Earnings category and postoperative performance tested for association with endoscopic and radiographic assessment of epiglottic size—Significant differences in epiglottic length were not evident between earnings category and performance before and after surgery. Significant change in earnings category for either breed was not evident after surgery. Of the 24 Thoroughbreds that had made at least 3 starts before and after surgery, 2 horses (8%) had improved earnings category, 18 horses (75%) had no change, and 4 horses (17%) had decreased earnings category. Of the 34 Standardbreds that had made at least 3 starts before and after surgery, 3 horses (9%) had improved earnings category, 26 horses (76%) had no change, and 5 horses (15%) had decreased earnings.

Performance after surgery was not significantly associated with epiglottic hypoplasia for either breed. In 100% of Thoroughbreds that appeared to have hypoplastic epiglottis by endoscopy, no change from the previous year’s performance was apparent. Among Thoroughbreds that appeared endoscopically normal, 22% had improved over the previous year’s performance, 67% had no change, and in 11%, performance decreased. Overall among Thoroughbreds, 17% improved in performance; in 75%, there was no change; and in 8%, performance decreased.

Among Standardbreds that had hypoplastic epiglottis determined by endoscopy, performance improved in 25%, remained the same in 50%, and decreased in 25%. Among Standardbreds that appeared endoscopically normal, performance improved in 22%, 74% had no change, and performance decreased in 4%. Overall, among Standardbreds, performance improved in 23%, 65% had no change, and performance decreased in 12%.

Discussion

Clinical recognition of epiglottic hypoplasia is important, because horses with hypoplastic epiglottis may be more susceptible to epiglottic entrapment or dorsal displacement of the soft palate, which usually results in abnormal respiratory tract noise and exercise intolerance during strenuous exercise. Lateral-view laryngeal radiography and flexible fiberoptic endoscopy of the upper airway are excellent methods of evaluating epiglottic size and contour in 2 planes that are set at right angles to one another. In horses with epiglottic entrapment, endoscopy provides information about thickness, width, ulceration, and color of the entrapping membranes. Endoscopy also provides subjective information about epiglottic length and contour and anatomic and functional relationship of the epiglottis to the soft palate. Laryngeal radiography (lateral view) allows for accurate measurement of thyroepiglottic length. Radiography also provides additional information concerning the anatomic relationship between the epiglottis and the soft palate, including structures beneath the epiglottis that cannot be visualized endoscopically.

A hypoplastic epiglottis appears abnormally short or narrow or thin or may have deformed border and contour. A severely hypoplastic epiglottis may have all of these abnormal characteristics. Epiglottic hypoplasia may render the epiglottis mechanically incapable of maintaining normal anatomic relationships with the aryepiglottic folds or the soft palate, particularly during maximal exertion. 3,4,10

Linford et al4 determined that Thoroughbred racehorses with epiglottic entrapment had significantly smaller thyroepiglottic length than did clinically normal Thoroughbreds. In this study, 35 Thoroughbred and 44 Standardbred horses with epiglottic entrapment also had significantly smaller thyroepiglottic length, measured from lateral-view laryngeal radiographs, than did clinically normal horses of the same breeds. However, epiglottic entrapment, usually associated with some degree of epiglottic hypoplasia, can also develop in horses with epiglottis of normal length. Among horses with entrapment, significant age or gender predilection was not evident for either breed. A significantly larger number of Standardbred racehorses than Thoroughbred racehorses were affected, compared with the expected breed distribution for the hospital population admitted to the University of Pennsylvania during the same period. 3

Within each breed, horses with epiglottic entrapment and endoscopically apparent epiglottic hypoplasia had significantly smaller thyroepiglottic length than did horses (with epiglottic entrapment) that appeared endoscopically normal. However, thyroepiglottic length overlapped between the groups of horses indicating that results of endoscopy and radiography probably should be evaluated together. Horses with normal thyroepiglottic length may have an abnormally thin or narrow epiglottis that is predisposed to dorsal displacement of the soft palate, resulting in an inability to perform. At the other extreme, are a Standardbred with thyroepiglottic length of 6.2 cm and a Thoroughbred with thyroepiglottic length of 5.87 cm, both with endoscopically hypoplastic epiglottis but both earning >$5,000 before and after surgery. Also, the total group of horses with epiglottic entrapment had significantly smaller thyroepiglottic
length than did clinically normal horses that did not have entrainment. An epiglottis that appears endoscopically hypoplastic may be more severely affected, but most horses with epiglottic entrainment have, at least, an abnormally short epiglottis. Allowance- and stakes-caliber horses of each breed performed well before and after surgery, but perhaps overall, the earnings categories and performance of every horse with entrainment would have been better if they had an anatomically normal epiglottis before beginning racing.

Performance after surgery was not significantly associated with endoscopically determined hypoplasia, and significant differences in epiglottic length between performance categories were not detected for either breed. After surgery, most horses raced at (Thoroughbreds, 75% [18/24]; Standardbreds, 65% [22/34]) or above (Thoroughbreds, 17% [4/24]; Standardbreds 23% [8/34]) their level of performance for the previous year. In 8% (2/24) of Thoroughbreds and 12% (4/34) of Standardbreds racing performance decreased. Also, significant change was not evident in earnings category for either breed. Seventy-five percent (18/24) of the Thoroughbreds and 76% (26/34) of the Standardbreds evaluated had no change in earnings category, but 8% (2/24) of Thoroughbreds and 9% (3/34) of Standardbreds had improved earning category. Earnings category decreased in 17% (4/24) of Thoroughbreds and 15% (5/34) of Standardbreds. After laser correction of epiglottic entrainment, earnings category and performance in Thoroughbred and Standardbred racehorses is likely to reflect the horse’s ability during the year prior to diagnosis of the entrainment. Radiographically determined thyroepiglottic length and endoscopic findings should be interpreted together with a knowledge of previous race earnings and performance before categorically issuing a poor prognosis for a successful racing career.

References