Comparison of clinical findings and short-term survival between horses with intestinal entrapment in the gastrosplenic ligament and horses with intestinal entrapment in the epiploic foramen

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OBJECTIVE
To compare clinical findings and short-term outcome for horses with intestinal entrapment in the gastrosplenic ligament (GLE) with those of horses with intestinal entrapment in the epiploic foramen (EFE).

DESIGN
Retrospective case-control study.

ANIMALS
43 horses with GLE (cases) and 73 horses with EFE (controls).

PROCEDURES
Medical records of horses examined because of colic at a veterinary teaching hospital between 1992 and 2012 were reviewed. Signalment was extracted from medical records for all horses with colic (colic population), and additional information regarding colic history, clinical findings, treatments, and outcome was extracted from the records of horses in which GLE or EFE was diagnosed during surgery or necropsy. Signalment was compared between the colic population and the case and control populations. Clinical findings and short-term outcome were compared between the cases and controls.

RESULTS
The proportions of middle-aged horses and geldings in both the case and control groups were greater than those in the colic population. Mean heart rate and blood and peritoneal fluid lactate concentrations in horses with EFE were significantly greater than those for horses with GLE. The proportion of horses that underwent surgery and were discharged from the hospital (short-term survival rate) did not differ between the GLE (22/25 [88%]) and EFE (29/34 [85%]) groups.

CONCLUSIONS AND CLINICAL RELEVANCE
Compared with the colic population, results suggested middle-aged geldings might be predisposed to GLE and EFE. The short-term survival rate was similar between the GLE and EFE groups even though horses with EFE had more severe systemic derangements than did horses with GLE. (J Am Vet Med Assoc 2016;249:660–667)

The gastrosplenic ligament is a thin, broad mesenteric band that extends from the greater curvature of the stomach to the cranial edge of the spleen. In horses, incarceration of a portion of the small intestine through a rent in the gastrosplenic ligament (GLE) is the cause of only 0.3% to 2% of all colics, but accounts for 4.5% to 10.7% of all primary small intestinal surgical lesions. The epiploic foramen is a 4- to 6-cm opening that separates the omental bursa from the rest of the abdominal cavity. Incarceration of a portion of the small intestine through the epiploic foramen (EFE) occurs more frequently than GLE, with a prevalence rate ranging from 2% to 10% of all surgical colics and accounts for 6% to 23% of small intestinal surgical lesions.

Although risk factors associated with EFE have been identified, few studies have been conducted to evaluate risk factors or specific clinical findings associated with GLE, at least not in a large population of horses. Elucidation of risk factors associated with GLE may provide insights into the etiology of acquired lesions, such as rents in the gastrosplenic ligament. The objective of the study reported here was to compare the clinical findings and short-

ABBREVIATIONS
CI  Confidence interval
EFE  Epiploic foramen entrapment
GLE  Gastrosplenic ligament entrapment
IQR  Interquartile range (25th to 75th percentile)
term outcome for horses with GLE with those of horses with EFE. We chose to compare horses with GLE with horses with EFE because it was our clinical impression that horses with those 2 types of lesions had similar clinical signs at hospital admission and were examined with sufficient frequency at our institution to allow for meaningful comparisons. We hypothesized that horses with GLE would have similar clinical signs and diagnostic test results but better short-term survival rate than horses with EFE.

Materials and Methods

Animals
The computerized medical record database of the William R. Pritchard Veterinary Medical Teaching Hospital was searched to identify horses that were examined because of colic from 1992 through 2012. Horses with a definitive diagnosis of GLE or EFE as determined by surgery or necropsy were defined as cases and controls, respectively. Horses with other more common types of strangulating small intestinal lesions such as strangulating lipomas were not included in the case or control group because horses with colic associated with those types of lesions tend to be older than horses with GLE or EFE and might have biased our results.

Data collection
The signalment (age, sex, and breed) was extracted from the medical records of all horses that were examined because of colic. Additional data extracted from the medical record of each case (GLE) and control (EFE) horse included history of previous colic surgery or cribbing behavior, duration of colic (< 6 hours, 6 to 12 hours, > 12 hours), temperature, heart rate, respiratory rate, PCV, blood lactate and total protein concentrations, presence of borborygmi (yes or no) and nasogastric reflux (> 2 L of fluid obtained following nasogastric intubation; yes or no), rectal examination findings, abdominal ultrasonographic findings, and results of abdominocentesis and cytologic evaluation of peritoneal fluid (when available) at hospital admission. For horses that underwent surgery, information was recorded regarding the location (GLE or EFE) of intestinal entrapment, segment of intestine entrapped (jejunum, jejunileum [included the distal portion of the jejunum and proximal portion of the ileum], ileum, or other), and whether an intestinal resection and anastomosis was performed or the horse was euthanized during surgery. All postoperative complications such as nasogastric reflux, diarrhea (> 1 bowel movement that produced feces that failed to remain on top of the stall bedding), and swelling or drainage from the surgical site > 48 hours after surgery were also recorded. For horses that were euthanized, all necropsy findings were recorded. Short-term survival was defined as the period from hospital admission to discharge, and horses were classified as either survivors or nonsurvivors.

Statistical analysis
The distributions of all continuous variables were assessed for normality by use of the Shapiro-Wilk test. Summary statistics were calculated for all variables. Results were reported as the mean ± SD for normally distributed continuous variables, median (IQR) for nonnormally distributed continuous variables, and number (percentage) of affected horses for categorical variables. The prevalence rates of horses with GLE and EFE were calculated as the number of cases or controls divided by the number of all horses examined because of colic (colic population), respectively.

Signalment variables were compared between the colic population and horses with GLE and EFE, respectively, and between horses with GLE and EFE by use of χ² tests. Because of the tabulated nature of the colic population data, age was converted to a categorical variable (< 1 year, 1 to 3 years, > 3 to 7 years, > 7 to 12 years, > 12 to 15 years, > 15 to 20 years, and > 20 years) for those comparisons.

All recorded variables were compared between cases and controls. Univariable comparisons were performed by use of the Student t test or Wilcoxon rank sum test for normally and nonnormally distributed continuous variables, respectively. Categorical variables were compared between cases and controls by use of χ² or Fisher exact tests when appropriate. Similar univariable comparisons between survivors (included horses with GLE and horses with EFE) and nonsurvivors were performed for all clinical variables.

Two multivariable logistic regression models were created to identify clinical variables that were associated with horses with GLE and short-term survival; the referents for those regression models were horses with EFE and nonsurvivors, respectively. For multivariable modeling, breed was dichotomized into large (Thoroughbred, warmblood, and draft) and small-medium (American Miniature Horse, Appaloosa, Arabian, Morgan, Paint Horse, Quarter Horse, Saddlebred, Tennessee Walking Horse, mule, and pony) size categories. Initially, univariable analyses were performed for each clinical variable, and variables with values of P < 0.20 were eligible for inclusion in the multivariable model. Each multivariable model was constructed in a stepwise manner, and only variables with values of P < 0.05 were retained in the final model. Model fit was assessed by use of the Hosmer-Lemeshow goodness-of-fit test. All analyses were performed with a commercial statistical software program, and values of P < 0.05 were considered significant for all analyses unless otherwise specified.

Results
Comparisons between the colic population and horses with GLE or EFE
Of the 9,755 horses examined for colic (colic population) from 1992 to 2012, 3,290 underwent surgery (surgical population). Subsequently, GLE was
diagnosed in 43 horses and EFE was diagnosed in 73 horses. Thus, prevalence of GLE and EFE in the colic population was 0.44% (95% CI, 0.33% to 0.59%) and 0.75% (0.60% to 0.94%), respectively, and the prevalence of GLE and EFE in the surgical population was 0.97% (95% CI, 0.69% to 1.37%) and 1.76% (95% CI, 1.31% to 2.21%), respectively.

The colic population consisted of 4,574 (47%) mares, 3,804 (39%) geldings, and 1,377 (14%) stallions. The frequency distribution for sex in the colic population differed significantly from that for both cases (horses with GLE) and controls (horses with EFE). Compared with the colic population, mares and stallions were significantly ($P \leq 0.04$ for all comparisons) underrepresented and geldings were overrepresented in both study groups.

The frequency distributions for breed and age in the colic population likewise differed significantly from those in the study groups. The proportion of Tennessee Walking Horses in the GLE group (5/43 [11.6%]) was significantly ($P < 0.001$) greater than that in the colic population (125/9,755 [1.3%]). Similarly, in the EFE group, the proportions of Thoroughbreds (23/73 [31.5%]), warmbloods (13/73 [17.8%]), and Morgans (6/73 [8.2%]) were significantly ($P \leq 0.02$ for all comparisons) greater, whereas the proportion of Quarter Horses and Paint Horses (13/73 [17.8%]) was significantly lower, compared with the proportions of Thoroughbreds (2,052/9,755 [21%]), warmbloods (886/9,755 [9%]), Morgans (281/9,755 [3%]), and Quarter Horses and Paint Horses (3,230/9,755 [33%]) in the colic population.

In the GLE group, the proportion of horses < 1 year old (0 [0%]) was significantly ($P = 0.01$ for all comparisons) lower, whereas the proportion of horses > 7 to 12 years old (17/43 [40%]) was significantly greater, compared with the proportion of horses < 1 year old (1,216/9,755 [12.5%]) and > 7 to 12 years old (2,147/9,755 [22%]) in the colic population. In the EFE group, the proportion of horses < 3 years old (2/72 [2.8%]; age was not recorded for 1 horse in the EFE group) was significantly ($P = 0.02$ for all comparisons) lower, whereas the proportion of horses > 12 to 20 years old (33/72 [45.8%]) was significantly greater, compared with the proportion of horses < 3 years old (2,296/9,755 [24%]) and > 12 to 20 years old (2,286/9,755 [23%]) in the colic population.

Clinical comparisons between horses with GLE and horses with EFE

The frequency distributions for breed and sex for both the GLE and EFE groups were summarized (Table 1). In the GLE group, the proportion of Thoroughbreds was significantly ($P = 0.04$) lower, whereas the proportion of Tennessee Walking Horses was significantly ($P = 0.03$) greater, compared with the corresponding proportions in the EFE group. The mean ± SD age for the horses with GLE (13.5 ± 5.7 years) did not differ significantly ($P = 0.34$) from that for horses with EFE (12.4 ± 5.5 years).

The duration of colic prior to hospital admission did not differ significantly ($P = 0.86$) between the GLE and EFE groups. Of the 43 horses with GLE, the duration of colic prior to hospital admission was < 6 hours for 10 (23%), > 6 to 12 hours for 25 (58%), and > 12 hours for 8 (19%). Of the 73 horses with EFE, the duration of colic prior to hospital admission was < 6 hours for 19 (26%), > 6 to 12 hours for 43 (59%), and > 12 hours for 11 (15%).

None of the horses with GLE and 11 of 73 (15%) horses with EFE had a history of prior colic surgery, and those 2 proportions differed significantly ($P = 0.007$). Of the 11 horses in the EFE group that had previously underwent surgery for colic, 5 had enteroliths removed, 4 had a large colon displacement, 1 had a small intestinal strangulating lipoma removed, and 1 had a fecalith removed; none had GLE or EFE at the time that procedure was performed.

Clinical and laboratory findings at hospital admission for both study groups were summarized (Table 2). The median heart rate ($P = 0.005$) and blood lactate concentration ($P < 0.001$) and mean peritoneal fluid lactate concentration ($P = 0.01$) for horses with GLE were significantly lower than those for horses with EFE and were at or above the upper limit of the respective reference intervals.

Variables eligible for assessment in the multivariable logistic regression model (ie, variables that had a value of $P < 0.20$ on univariable analysis) included breed, prior colic surgery, heart rate, respiratory rate, blood lactate concentration, and peritoneal fluid lactate concentration. The final multivariable model included breed and peritoneal fluid lactate concentration. Horses with GLE were approximately 15 times (OR, 14.9; 95% CI, 2.7 to 82.3; $P = 0.002$) as likely to be of small- or medium-sized breeds than were horses.

Table 1—Comparison of breed and sex between horses with GLE (n = 43) and horses with EFE (73) that were examined at a veterinary teaching hospital from 1992 through 2012.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Horses with GLE</th>
<th>Horses with EFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quarter Horse and Paint Horse</td>
<td>10 (23.3)</td>
<td>13 (17.8)</td>
</tr>
<tr>
<td>Thoroughbred</td>
<td>6 (14.0)*</td>
<td>23 (31.5)</td>
</tr>
<tr>
<td>Warmblood</td>
<td>7 (16.3)</td>
<td>13 (17.8)</td>
</tr>
<tr>
<td>Arabian</td>
<td>7 (16.3)</td>
<td>7 (10.0)</td>
</tr>
<tr>
<td>Tennessee Walking Horse</td>
<td>5 (11.6)*</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Morgan</td>
<td>0 (0)</td>
<td>6 (8.2)</td>
</tr>
<tr>
<td>Other†</td>
<td>8 (18.6)</td>
<td>10 (13.7)</td>
</tr>
<tr>
<td>Sex‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mare</td>
<td>9 (20.9)</td>
<td>25 (34.2)</td>
</tr>
<tr>
<td>Geling</td>
<td>33 (76.7)</td>
<td>45 (61.6)</td>
</tr>
<tr>
<td>Stallion</td>
<td>1 (2.3)</td>
<td>2 (2.7)</td>
</tr>
</tbody>
</table>

Values represent the number (%).

*Value differs significantly ($P < 0.05$) from the corresponding value for horses with EFE. †The other category for horses with GLE included 2 draft-type horses, 1 pony, 2 Appaloosas, 1 Saddlebred, and 2 mules, and that for horses with EFE included 2 draft-type horses, 2 ponies, 4 Appaloosas, 1 American Miniature Horse, and 1 Saddlebred. ‡The sex was not recorded for 1 horse with EFE.
Equine with EFE (ie, horses with EFE were more likely to be large-breed horses than were horses with GLE). The odds that GLE would be diagnosed decreased by 20% (OR, 0.8; 95% CI, 0.6 to 0.9; \(P = 0.004\)) for each 1 mmol/L increase in peritoneal fluid lactate concentration (ie, the odds that a horse had EFE increased as peritoneal fluid lactate concentration increased).

### Surgical comparisons between horses with GLE and horses with EFE

Of the 43 horses with GLE, 32 (74%) underwent surgery and 11 (26%) were euthanized without surgery because of a poor prognosis (eg, strangulating small intestinal lesion) or financial constraints. The intestinal portion entrapped within the gastrosplenic ligament was the jejunum only in 28 (65%) horses, jejunoileum in 9 (21%) horses, ileum only in 4 (9%) horses, and large colon in 2 (5%) horses. Of the 32 horses that underwent surgery, an intestinal resection and anastomosis was performed in 20 (63%) horses (jejunojejunostomy \([n = 17\) horses], jejunoileostomy \([2],\) or jejunocecostomy \([1]\)). The mean length of intestine resected was 3 m (range, 0.9 to 6.1 m). Intestinal resection and anastomosis was not necessary in 5 horses, and 7 horses were euthanized during surgery because the owners declined further treatment owing to the extent of compromised bowel and need for intestinal resection.

Of the 25 horses with GLE that were recovered from surgery, 16 developed postoperative complications that included nasogastric reflux (\(n = 8\)), severe postoperative colic (6; included 5 horses that also developed postoperative nasogastric reflux), incisional complications (2), hemoabdomen that necessitated a blood transfusion (2), and jugular thrombophlebitis, mild intermittent colic, and septic peritonitis (1 each). Three of the horses that developed postoperative complications were subsequently euthanized; all had severe postoperative colic and were euthanized without \((n = 1)\) or during \((2)\) a second celiotomy. Those 2 horses were euthanized because of the extent of compromised or nonviable intestine discovered during the second surgery. The remaining 3 horses that developed severe postoperative colic also underwent a second celiotomy and survived. Surgical findings for those horses included ileus \((n = 1),\)

### Table 2—Summary statistics for various clinical findings for the horses of Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Reference interval</th>
<th>Horses with GLE</th>
<th>Horses with EFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>37.2–38.3</td>
<td>37.3 ± 1.0</td>
<td>37.3 ± 1.0</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>28–44</td>
<td>34 (26–61)</td>
<td>58 (48–72)</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>8–16</td>
<td>24 (20–30)</td>
<td>20 (16–28)</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>30–37</td>
<td>34 (30–40)</td>
<td>33 (30–39)</td>
</tr>
<tr>
<td>Blood total protein (g/dL)</td>
<td>5.8–7.5</td>
<td>6.8 ± 1.1</td>
<td>6.5 ± 0.7</td>
</tr>
<tr>
<td>Blood lactate (mmol/L)</td>
<td>&lt; 2.0</td>
<td>2.1 (1.4–3.6)</td>
<td>6.2 (2.3–9.4)</td>
</tr>
<tr>
<td>Peritoneal fluid total cell count (cells/µL)</td>
<td>&lt; 2,500</td>
<td>850 (500–2,900)</td>
<td>800 (500–4,400)</td>
</tr>
<tr>
<td>Peritoneal fluid total protein (g/dL)</td>
<td>&lt; 2.0</td>
<td>3.8 ± 1.4</td>
<td>3.7 ± 1.3</td>
</tr>
<tr>
<td>Peritoneal fluid lactate (mmol/L)</td>
<td>&lt; 2.0</td>
<td>5.3 ± 3.8</td>
<td>9.4 ± 6.2</td>
</tr>
</tbody>
</table>

Intestinal borborygmi
- Normal — 0 (0) 1 (1.4)
- Decreased — 12 (27.9) 24 (32.9)
- Absent — 31 (72.1) 48 (65.8)

Nasogastric reflux†
- No — 12 (30) 45 (61.6)
- Yes — 28 (70) 28 (38.4)

Rectal examination findings
- Unremarkable — 4 (9.5) 9 (13.0)
- Small intestinal abnormality — 25 (59.5) 38 (55.1)
- Large intestinal abnormality — 13 (31.0) 22 (31.9)

Abdominal ultrasonographic findings
- Unremarkable — 2 (8) 4 (10.3)
- Distended small intestine — 23 (92) 35 (89.7)

Gross appearance of peritoneal fluid
- Pale yellow and clear — 4 (10) 2 (3.3)
- Yellow and cloudy — 1 (2.5) 5 (8.3)
- Serosanguinous — 35 (87.5) 53 (88.3)

Cribbing behavior
- Yes — 1 (2.3) 6 (8.2)
- No — 1 (2.3) 4 (5.5)
- Not recorded — 41 (95.3) 63 (86.3)

Values represent the mean ± SD, median (IQR), or number (%). Results for some variables were not recorded in the medical record for some horses. Therefore, the number of horses that contributed to the calculation of the summary statistic varied among variables, and the numbers in brackets following the mean ± SD or median (IQR) represent the number of horses that contributed to that summary statistic. Within a study group (horses with GLE or horses with EFE), percentages for some categorical variables may not total 100 because of rounding.

— = Not applicable.

See Table 1 for remainder of key.
colonic torsion (1), and impaction at the anastomosis site (1). Overall, 22 of the 25 (88%) horses with GLE that underwent surgery were classified as survivors; 9 recovered without complications, and 13 of the 16 horses that developed postoperative complications also recovered.

Of the 73 horses with EFE, 58 (79%) underwent surgery and 15 (21%) were euthanized without surgery because of a poor prognosis (eg, strangulating small intestinal lesion) or financial constraints. The intestinal portion entrapped in the epiploic foramen was the jejunum only in 36 (49%) horses, jejunileum in 25 (34%) horses, and ileum only in 12 (16%) horses. Of the 58 horses that underwent surgery, an intestinal resection and anastomosis was performed in 18 (31%) horses (jejunojjunostomy [8], jeunocecostomy [7], or jejunoleostomy [3]). The mean length of intestine resected was 4.6 m (range, 0.9 to 10.1 m). Intestinal resection and anastomosis was not necessary in 16 horses. Twenty-four horses were euthanized during surgery; 17 because the owners declined further treatment owing to the extent of compromised bowel and the need for intestinal resection and 7 because of massive intraoperative hemorrhage from the portal vein (n = 4), mesenteric vessels (1), or some other unidentified source (2).

Of the 34 horses with EFE that were recovered from surgery, 24 (70.6%) developed postoperative complications that included nasogastric reflux (n = 13), severe postoperative colic (6; all 6 also developed nasogastric reflux), incisional complications (4), mild diarrhea (3), mild colic (2), hemoabdomen that did not necessitate a blood transfusion (1), and severe enterocolitis caused by Clostridium difficile and an unspeciated Salmonella sp (1). Five of the horses that developed postoperative complications, including 4 with postoperative reflux and colic and 1 horse with severe enterocolitis, were subsequently euthanized. Of the 4 with postoperative reflux and colic and 1 horse with severe enterocolitis, 1 horse was euthanized during an attempted revision of the jejunojjunostomy because of adhesions, and 1 horse was euthanized following the second celiotomy (ileus was diagnosed) because of continued nasogastric reflux. The remaining 2 horses that developed severe postoperative colic and nasogastric reflux underwent additional surgery. One horse recovered following a jejunoccecostomy revision. The other horse also underwent a jejunoccecostomy revision and developed cecal dysfunction, which required a third celiotomy. That horse eventually recovered and was classified as a survivor. Overall, 29 of 34 (85%) horses with EFE that underwent surgery were classified as survivors; 10 recovered without complications, and 19 of 24 horses that developed postoperative complications also recovered. The incidences of postoperative complications and the development of postoperative nasogastric reflux did not differ significantly between horses with GLE and horses with EFE.

Factors associated with short-term survival

The overall short-term survival rate for horses with GLE (22/43 [51%]) did not differ significantly (P = 0.23) from that for horses with EFE (29/73 [40%]). Similarly, the proportion of horses with GLE that underwent surgery and survived (22/25 [88%]) did not differ significantly (P = 0.76) from the proportion of horses with EFE that underwent surgery and survived (29/34 [85%]). Therefore, the data from the 2 groups were pooled together for evaluation of factors associated with survival (ie, discharged from the hospital alive). Univariable analyses revealed that the mean ± SD peritoneal fluid total protein concentration (3.2 ± 1.1 g/dL) and peritoneal fluid lactate concentration (4.8 ± 2.5 mmol/L) for horses that survived were significantly lower than the mean ± SD peritoneal fluid total protein concentration (4.7 ± 0.6 g/dL; P = 0.001) and peritoneal fluid lactate concentration (10.5 ± 4.2 mmol/L; P = 0.008) for horses that did not survive. The proportion of horses that developed postoperative nasogastric reflux and survived (14/21 [67%]) was significantly (P < 0.001) lower than the proportion of horses that did not develop postoperative nasogastric reflux and survived (37/38 [97%]). Although the proportion of horses that underwent an intestinal resection and anastomosis and survived (31/38 [82%]) was lower than the proportion of horses that did not undergo an intestinal resection and anastomosis and survived (20/21 [95%]), those 2 proportions did not differ significantly (P = 0.14). Thus, the variables eligible for consideration in the multivariable logistic regression model were peritoneal fluid total protein concentration, peritoneal fluid lactate concentration, and the development of postoperative nasogastric reflux.

The final multivariable regression model included development of postoperative nasogastric reflux and peritoneal fluid total protein concentration. The fixed effect for the development of postoperative nasogastric reflux was not significant, but its inclusion improved the model fit so it was retained in the final model. The odds for survival were decreased by 89% (OR, 0.11; 95% CI, 0.01 to 1.10; P = 0.06) for horses that developed postoperative nasogastric reflux, compared with odds for horses that did not develop postoperative nasogastric reflux. Similarly, the odds for survival decreased by 64% (OR, 0.36; 95% CI, 0.13 to 0.96; P = 0.04) for each 1 g/dL increase in peritoneal fluid total protein concentration.

Discussion

Results of the present study indicated that there were more similarities than differences between horses with GLE and horses with EFE in terms of clinical findings and short-term survival. The prevalence rates of horses with GLE (43/9,755 [0.44%]) and EFE (73/9,755 [0.75%]) within the colic population (the number of all horses examined because of colic at the veterinary teaching hospital for the duration of the
study observation period [1992 to 2012]) were similar to those of previous studies.\textsuperscript{2,3}

Although horses of various ages (range, 2 to 25 years) were represented in both the case and control groups, middle-aged (8 to 20 years) horses were overrepresented in both groups, compared with the age distribution for the colic population. Similarly, there were proportionately more geldings in both study groups than in the colic population. Those age and sex predispositions have been described for horses with EFE,\textsuperscript{7,16} and the gelding predisposition has likewise been described for horses with GLE.\textsuperscript{2,4,17,18} The reason for those predispositions is unknown. The fact that middle-aged horses are predisposed to GLE and EFE suggests that those 2 conditions are not the result of congenital abnormalities. The gelding predisposition eliminates pregnancy and dystocia as common causes of gastroplenic rents, and leads us to suspect that trauma may have a role in both conditions, especially GLE.

The Thoroughbred breed and height have been positively associated with EFE in other studies.\textsuperscript{13,16} A positive association between height and EFE might explain, at least in part, the positive association between warmblood breeds and EFE observed in the present study. The observation that Tennessee Walking Horses and Morgans appeared to be overrepresented in the GLE group, compared with the colic population, was likely artifact owing to the low number of horses of those 2 breeds in the colic population. Results of another study\textsuperscript{4} suggest that Quarter Horses and Quarter Horse-type breeds are predisposed to the development of GLE. We did not identify a similar predisposition in the present study; however, we attributed this to the fact that the referent group for that other study\textsuperscript{4} included horses with all types of strangulating small intestinal lesions and had a proportionately high number of horses with strangulating lipomas (horses which were excluded from the present study) and a proportionately low number of horses with EFE.

Investigators of previous studies\textsuperscript{13,14,16} report a strong positive association between cribbing and EFE. In the present study, the prevalence of cribbing did not differ significantly between horses with GLE and horses with EFE. That finding was most likely the result of incomplete recording of cribbing history in the medical records of many horses, but it might also suggest that cribbing is positively associated with GLE as well as EFE. The prevalence of cribbing in the present study was most likely underestimated because of the study’s retrospective nature, and we cannot rule out cribbing as a cause of chronic colic in some of the study horses.

A previous episode of colic is a risk factor for subsequent bouts of colic in general.\textsuperscript{13,14,19,20} Horses that had a colic episode within the previous 12 months were 4.4 times as likely to develop EFE, compared with horses that did not have a colic episode within the previous 12 months.\textsuperscript{13} In the present study, none of the horses with GLE and 11 of 73 (15%) horses with EFE had undergone a previous surgery for colic. Results of univariable regression analysis revealed that previous colic surgery was positively associated with horses with EFE; however, it was not retained in the final multivariable model. To our knowledge, prior to the present study, a positive association between previous colic surgery and the incidence of EFE had not been reported, and the mechanism for that association is not intuitive. It would seem that inadvertent surgical trauma would be more likely to result in an acquired lesion such as a rent within the gastroplenic ligament than damage to a static anatomic structure such as the epiploic foramen.

Results of the present study indicated that the mean heart rate and blood and peritoneal fluid lactate concentrations for horses with EFE were significantly greater than those for horses with GLE. Additionally, the increase in peritoneal fluid lactate concentration was proportional to the increase in blood lactate concentration in both study groups. The increases in blood and peritoneal fluid lactate concentrations observed in both study groups were indicative of strangulating intestinal lesions; however, the fact that the mean heart rate and blood lactate concentration were significantly higher for the EFE group than the GLE group suggested that horses with EFE were more severely compromised than were horses with GLE. Interestingly, the observed discrepancy in the systemic status between horses with EFE and horses with GLE did not appear to be associated with the duration of colic, PCV, and blood total protein concentration because the means for those variables did not differ significantly between the 2 study groups. It is possible that horses with EFE were more painful than horses with GLE, which might explain why horses with EFE had a higher heart rate than horses with GLE, but signs of pain were not assessed in the present study. The fairly close proximity of the epiploic foramen to the pancreas and liver might induce secondary effects on those organs that could affect the clinical severity of EFE.

For most horses of the present study, the lesion was localized to the small intestine on the basis of clinical findings obtained during the initial colic examination. Of the 111 horses evaluated in the present study for which a rectal examination was performed, 63 (56.8%) had small intestinal abnormalities identified during rectal examination and only 56 of 115 (49.5%) horses in which a nasogastric tube was passed had nasogastric reflux during the initial colic examination. Results of abdominal ultrasonography revealed small intestinal distention in 23 of 25 (92%) horses with GLE and 35 of 39 (90%) horses with EFE; abdominal ultrasonography was not performed on the remaining study horses. Unfortunately, for many horses, the information recorded in the medical record was not sufficient to definitively ascertain the location of the small intestinal distention identified during abdominal ultrasonography. When abdomi-
nal ultrasonography is performed on the left side, evidence of distended, immotile, edematous loops of small intestine lateral to the spleen may be indicative of GLE, and when ultrasonography is performed on the right side, evidence of immotile, edematous loops of small intestine where the liver is usually imaged is associated with EFE. Of the 58 horses with EFE that underwent surgery, 24 (41%) were euthanized during surgery. Most of those horses had entrapments that involved the jejunoileum (distal portion of the jejunum and proximal portion of the ileum) and required a resection of an extensive portion of the intestine or jejunocostomy. The decision to euthanize may have been influenced by a perception on the part of the owner or surgeon that those procedures were associated with a poor prognosis. Although a direct association between the length of intestine resected and prognosis has not been identified, the resection of extensive portions of the small intestine is associated with an increase in the risk for the development of postoperative ileus, which can affect prognosis indirectly. The prognosis for jejunocostomy is not as good as that for jejunoojenostomy, likely because it is a more complex surgery. Even though it is important for surgeons to inform owners of the expected prognoses and outcomes, it is equally important that they be willing to challenge preconceived conclusions and attempt difficult procedures or treatment for patients if the owners of those patients are informed and willing.

Seven of the 58 (12%) horses with EFE that underwent surgery were euthanized during surgery because of severe hemorrhage; this was similar to the proportion (3/26 [11.5%]) of horses with EFE that developed fatal hemorrhage in another study. Severe intraoperative hemorrhage can result from spontaneous rupture of the portal vein because of necrosis and increased pressure induced by the incarcerated portion of the small intestine or tearing of the portal vein or mesenteric vessels during manual reduction of the entrapped portion of the intestine.

The postoperative complication and short-term survival rates were comparable and the number of horses that required a second celiotomy did not differ significantly between the 2 study groups. The incidence of postoperative nasogastric reflux, which is often associated with the need for additional surgery, did not differ significantly between horses with GLE and horses with EFE, but it was negatively associated with survival. That finding highlighted the importance of the implementation of appropriate surgical techniques and diligent postoperative management for the prevention and management of postoperative nasogastric reflux. It also supported the findings of other studies and emphasized the prognostic significance of postoperative nasogastric reflux for horses with strangulating small intestinal lesions.

In the present study, 22 of 25 (88%) horses with GLE and 29 of 34 (85%) of horses with EFE that were recovered from the initial celiotomy survived and were discharged from the hospital. It is difficult to compare survival rates among studies because they involve different institutions, time periods, and case populations. For horses with GLE that are allowed to recover from celiotomy, the short-term (discharge from the hospital) survival rate ranges from 72.7% to 84%, and the long-term survival rate is reported to be 79%. Freeman et al reported that horses with EFE were more likely to be discharged from the hospital than horses with other types of strangulating small intestinal lesions. Other reported short-term survival rates after surgery for horses with EFE vary from 69% to 88%.

Few variables assessed in the present study were significantly associated with short-term survival on either univariable or multivariable analysis. Although the power for those analyses was limited because of the large number of horses euthanized without treatment or during surgery, the variables that were significantly associated with short-term survival (peritoneal fluid total protein and lactate concentrations and postoperative nasogastric reflux) were indicative of severe intestinal compromise. Thus, the findings of the present study supported the current clinical recommendation that horses with small intestinal strangulations be treated as soon as possible to avoid severe systemic and intestinal derangements and improve prognosis. A higher proportion of horses that did not undergo a resection and anastomosis survived (20/21 [95%]), compared with the proportion of horses that did undergo a resection and anastomosis (31/38 [82%]), which is comparable to the findings of a previous study.

The main limitations of the present study were those typical of any retrospective study. Bias associated with case management, surgeon preference, and the influence of the anatomic site of the lesion could not be controlled. Retrieval of data was limited by the completeness and accuracy of the medical records. The 20-year duration of the study contributed to variability associated with personnel changes, clinical advances, variations in economic climate, and difficulty in attaining long-term follow-up on cases and controls. The statistical power of the study was limited because of the overall uncommon occurrence of GLE and EFE and incomplete or unavailable medical record data.

Results of the present study suggested that GLE and EFE should be included on the differential diagnosis list for middle-age horses and geldings with clinical signs consistent with small intestinal strangulation. Prior colic surgery may increase the risk for the subsequent development of EFE. Although intestinal resection and anastomosis is often necessary for horses with GLE and horses with EFE, short-term survival is favorable for treated horses. Early treatment of horses with those types of strangulating small intestinal lesions is expected to improve the prognosis for survival.
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Footnotes

References