The full details of the published version of the article are as follows:

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JOURNAL TITLE: Journal of the American Veterinary Medical Association

VOLUME/EDITION: 246/5

PUBLISHER: American Veterinary Medical Association

PUBLICATION DATE: March 2015

DOI: 10.2460/javma.246.5.540

Indications, complications, and outcome of horses undergoing repeated celiotomy within 14 days after the first colic surgery: 95 cases (2005–2013)

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Objective—To examine factors associated with short- and long-term prognosis for horses undergoing repeated celiotomy within 14 days after the first colic surgery.

Design—Retrospective case series.

Animals—95 horses that had undergone 2 celiotomies within a 14-day period between 2005 and 2013 at 3 equine referral hospitals.

Procedures—Historical, clinical, and laboratory data were compared between horses that did not survive and horses that did survive to hospital discharge (short-term survival rate) and to > 3 and > 6 months after hospital discharge (long-term survival rates).

Results—Strangulating small intestinal lesions were the most common finding during the first celiotomy (60/95 [63.2%]), and persistent gastric reflux was the most common reason for the second celiotomy (56/95 [58.9%]). Reasons for a second celiotomy were not associated with survival rate. For horses that had long-term follow-up, 22 of 92 (23.9%) survived > 6 months after hospital discharge. Two of 13 horses with intestinal resections during both surgeries survived to > 6 months after hospital discharge. Compared with horses not undergoing intestinal resection, significantly fewer horses requiring resection during 1 or both surgeries survived to hospital discharge and to > 3 and > 6 months after hospital discharge. Incisional infections occurred in 68.4% (26/38) of horses that survived to hospital discharge, and 31.6% (12/38) developed incisional hernias or dehiscence.

Conclusions and Clinical Relevance—Results indicated that the prognosis for horses undergoing repeated celiotomy is guarded, and intestinal resection negatively affects the long-term survival rate. (*J Am Vet Med Assoc* 2015;246:540–546)

Indications, complications, and prognosis for horses undergoing exploratory colic surgery for a variety of conditions have been extensively described.[1–9] Although the quality of care and rate of survival to hospital discharge for horses undergoing colic surgery have increased over the past decades and are now generally considered good, several complications can occur during the immediate postoperative period, which influence short- and long-term outcome.[5,10]

Postoperative ileus and recurring colic are considered the most commonly encountered problems and, if severe or unrelenting, might require a second celiotomy shortly after the first procedure. Little information is available about horses requiring a second abdominal surgery shortly after the first procedure; to our knowledge, only 1 study[11] has focused on this population specifically. That 2005 study,[11] performed at a single equine referral hospital, included 27 horses undergoing repeated celiotomy within 14 days of the first celiotomy and reported a low long-term survival rate of 22.2%.

Whereas the financial and emotional impact encountered by the client is substantial, an accurate estimation of short- and long-term survival rates appears important but larger-scale studies investigating outcome are lacking. The purpose of the study reported here was to describe indications, findings, complications, and prognosis for horses undergoing 2 abdominal surgeries for colic within a 14-day period and to compare data between those that did not survive and those that survived in the short and long term. We hypothesized that horses undergoing repeated celiotomy because of persistent gastric reflux would have a worse short-term prognosis than horses undergoing repeated celiotomy for other reasons and that the requirement for intestinal resection and anastomosis during the first or second celiotomy would influence the long-term outcome negatively.

Materials and Methods

Case selection—Medical records (January 2005 to November 2013) from 3 equine referral hospitals in the

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Presented in abstract form at the 11th International Colic Research Symposium, Dublin, Ireland, July 2014; and the 23rd Annual Scientific Meeting of the European College of Veterinary Surgeons, Copenhagen, July 2014.

The authors thank Hayley Whitaker and Lynn Irving for help in locating files.

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United Kingdom (The Royal Veterinary College Equine Referral Hospital, Rossdales Equine Hospital and Diagnostic Centre, and Bell Equine Veterinary Clinic) were reviewed to identify horses that had undergone 2 consecutive abdominal surgeries for colic within 14 days, either as a result of complications arising from the first celiotomy, including incisional dehiscence, or because of newly developed problems.

Medical records review—Signalment, history (duration of clinical signs), clinical findings (heart and respiratory rates, rectal temperature, and presence and volume of gastric reflux), and laboratory values (plasma lactate, total protein, and creatinine concentrations; PCV and WBC count; and peritoneal fluid nucleated cell count and protein concentration) were obtained from the medical record of each horse.

Procedures—Breeds were grouped as Thoroughbred and Thoroughbred cross, warmblood, pony, draft horse, and other. Heart and respiratory rates and rectal temperatures (the highest value of the day) were recorded for the first 2 days after the first and second celiotomy and for the third day after the second celiotomy. Use of prokinetic drugs after the first and second celiotomy, presence and daily volume of gastric reflux, colic signs, and need for additional analgesia were noted over the same period, but also for the third day after the second celiotomy. Ileus was defined as > 2 L of gastric reflux fluid on nasogastric intubation in the absence of mechanical obstruction.[11] Presence or absence of ileus was determined during the second celiotomy once other reasons for gastric reflux had been ruled out. Findings during the first celiotomy (small vs large intestinal lesion, strangulating vs nonstrangulating lesion, and strangulating small intestinal lesion vs other lesions), procedure performed (abdominal exploration only, intestinal resection and anastomosis, or enterotomy with or without intestinal resection), type of small intestinal anastomosis (jejunojejunostomy, jejunoileostomy, or jejunocecostomy), and anesthetic time were recorded. Time between surgeries, reasons for the second celiotomy (gastric reflux or generalized small intestinal distension visible ultrasonographically or palpated per rectum, colic with or without gastric reflux, incisional complications, or other), surgical access through the same or a separate ventral incision, findings during the second celiotomy (generalized distended small intestine without obvious cause or ileus, problem involving anastomosis, beginning or established adhesion formation, or other), and whether a second intestinal resection was required were also included. Small intestinal distension proximal to the anastomosis site but not distally, kinking, and impaction at the anastomosis site were categorized as technical problems directly relating to the first intestinal anastomosis. The presence of an incisional infection (discharge evident > 24 hours after surgery) before or after the second celiotomy was noted. Some horses had postoperative serosanguineous drainage for 12 to 24 hours, particularly after the second celiotomy. This often subsided without developing other incisional complications and was not considered evidence of infection. Outcome was categorized by survival time as follows: short-term survival rate (number of horses that survived to hospital discharge), long-term survival rates (number of horses that survived to > 3 and > 6 months after hospital discharge), and nonsurvival rate (number of horses that died after hospital discharge). Follow-up information including whether the horse was alive and, if not, reason and time of death or euthanasia; whether the horse had further colic episode; and whether any incisional complications (infection or hernia formation) occurred was obtained for each horse by telephone conversation with owners, trainers, or referring veterinary surgeons.

Statistical analysis—Data were analyzed with the aid of a commercially available software package.[a] Continuous data were expressed as mean ± SD if normally distributed or median (range) if nonnormally distributed, and categorical data were presented as numbers and percentages. Normality of the data was assessed on the basis of the Shapiro-Wilk test, and comparisons between horses that did not survive after hospital discharge and horses that survived to hospital discharge and to > 3 months and > 6 months after hospital discharge were made by means of 2-sample *t* test (normally distributed continuous data), Mann-Whitney *U* test (nonnormally distributed continuous data), χ^2 test, or Fisher exact test (categorical data). Further comparisons included reasons for a second celiotomy between the different small intestinal anastomosis types (Fisher exact test) and clinical findings between surgeries in horses with ileus, compared with horses with complications relating to the anastomosis site (2-sample *t* tests or Mann-Whitney *U* tests). A Kaplan-Meier survival plot was generated. Significance was set at $P \leq 0.05$.

Results

Study population—Ninety-five horses met the inclusion criteria for the study. The 3 hospitals contributed 27, 28, and 40 cases (approx 6.8% [27/397], 4.8% [28/583], and 7.2% [40/556] of all horses undergoing colic surgery at the respective hospitals). Median age of horses was 12 years (range, 0.125 to 40 years). Breed was recorded for 88 horses (36 warmbloods, 29 Thoroughbreds, 13 ponies, 1 draft horse, and 9 other breeds). Thirty-five horses were mares, 54 were geldings, and 6 were stallions.

Findings before the second celiotomy—Median duration of signs prior to the first hospital admission was 6 hours (1.0 to 72 hours; n = 56). Strangulating small intestinal (60/95 [63.2%]) and large intestinal (17/95 [17.9%]) lesions were the most common finding during the first celiotomy with intestinal resection being required in 57 (60%) horses (5 large intestinal and 52 small intestinal lesions, including 24 jejunojejunostomy, 13 jejunocecostomy, and 15 jejunoileostomy procedures). Nine horses each had nonstrangulating small intestinal and large intestinal disorders. No significant differences in clinical and laboratory measurements at the time of hospital admission were detected between horses with small intestinal and large intestinal lesions, but anesthesia time was significantly ($P = 0.044$) longer in horses with large intestinal resections (median, 230 minutes; range, 210 to 290 minutes; n = 3), compared with

small intestinal resections (median, 180 minutes; range, 120 to 300 minutes; n = 50). Lidocaine was used as a prokinetic after the first celiotomy in 74 of 95 (77.9%) horses. In 14 horses, the drug was combined with either metoclopramide or erythromycin; 10 horses did not receive a prokinetic, and no information was available for 11 horses. Median duration between the 2 surgeries was 3 days (range, 0.5 to 13 days), and persistent gastric reflux was the most common reason for performing repeated celiotomy (56/95 [58.9%]), followed by recurrent or persisting signs of abdominal pain with or without gastric reflux (46/95 [48.4%]) and incisional complications (8/95 [8.4%]). The time between first and second celiotomy, categorized by reasons for the procedure, was summarized (**Table 1**). Horses with small intestinal lesions had significantly ($P < 0.001$) more gastric reflux fluid, compared with horses with large intestinal lesions, on the first (median, 10.3 L [range, 0 to 110 L] vs 0 L [range, 0 to 51 L]) and second (median, 9.8 L [range, 0 to 114 L] vs 0 L [range, 0 to 52 L]) day after the first celiotomy and on the day of the second celiotomy (median, 9.0 L [range, 0 to 70 L] vs 0 L [range, 0 to 7 L]). Reasons for the second celiotomy also differed between horses with small intestinal and large intestinal lesions. Proportionally more horses with small intestinal lesions, compared with horses with large intestinal lesions, were reevaluated because of gastric reflux or distended small intestine (51/69 [73.9%] vs 5/26 [19.2%]; $P < 0.001$). Proportionally fewer horses with small intestinal lesions, compared with horses with large intestinal lesions, were reevaluated because of colic (27/69 [39.1%] vs 17/26 [65.4%]; $P = 0.02$) or incisional problems (2/69 [2.9%] vs 6/26 [23.1%]; $P = 0.005$). The reasons for a repeated celiotomy did not differ between small intestinal anastomosis types. Only 1 horse was discharged from the hospital between surgeries. This horse was discharged 8 days after the first surgery and returned 2 days later for repair of an incisional breakdown with omental prolapse.

Findings during the second surgery—In all but 1 horse, where a paramedian approach was used during the second surgery, the same abdominal incision was used. The most common finding during the second surgery was paralytic ileus (33/95 [34.7%]), whereas problems with the original anastomosis site were noted in 17 of 57 (29.8%) horses that had undergone intestinal resection during the first procedure. Ileus was more common in horses originally examined for a small intestinal lesion (31/69 vs 2/26; $P = 0.001$), whereas problems with the anastomosis site or requirement for a second intestinal resection were not different between horses originally evaluated because of small intestinal or large intestinal lesions. None of the clinical and laboratory measurements obtained between surgeries differed between horses with paralytic ileus and those with anastomosis problems. However, horses with ileus, compared with horses with anastomosis problems, had significantly more gastric reflux fluid on the second day after the first celiotomy (median, 38.5 L [0 to 113.5 L] vs 0 L [0 to 71 L]; $P = 0.005$) and on the day of the second celiotomy (median, 15 L [0 to 45 L] vs 0 L [0 to 32 L]; $P = 0.002$). Furthermore, significantly ($P = 0.05$) more horses with ileus required additional analgesia on the first day after the first celiotomy (16/29 [55.2%] horses with ileus vs 4/16 [25%] with anastomosis problems).

Of 56 horses that underwent repeated celiotomy because of persistent gastric reflux, 40 (71.4%) had had intestinal resection performed previously and gastric reflux resolved in 14 of 56 (25%) after the second celiotomy. Six of these 14 horses had ileus diagnosed during the second celiotomy, and 5 had developed complications at the anastomosis site. In 3 horses, the presumed reason for the gastric reflux could not be identified from the records.

All horses undergoing a second celiotomy for incisional complications also had their abdomen explored during the second procedure, and additional lesions were identified in 6 of 8 horses (adhesions between intestine and body wall [n = 2], small colon impaction [1], right dorsal displacement [1], omental prolapse [1], and small intestinal entrapment between cecum and jejunocecostomy [1]).

Table 1—Number (%) of 95 horses undergoing repeated celiotomy for persistent gastric reflux, colic, gastric reflux and colic, and incisional complications by time between first and second celiotomy.

Time between first and second celiotomy (d)	Total No. (%) of horses	Cumulative No. (%) of horses	Reason for second celiotomy*			
			Gastric reflux (n = 40)	Colic (n = 25)	Gastric reflux and colic (n = 21)	Incisional complication (n = 8)
1	25 (26.3)	25 (26)	6 (15)	10 (40)	8 (38.1)	1 (12.5)
2	16 (16.8)	41 (43.2)	6 (15)	3 (12)	7 (33.3)	0 (0)
3	18 (18.9)	59 (61.1)	12 (30)	2 (8)	3 (14.3)	1 (12.5)
4	13 (13.7)	72 (75.8)	9 (22.5)	2 (8)	1 (4.8)	1 (12.5)
5	10 (10.5)	82 (86.3)	4 (10)	3 (12)	2 (9.5)	2 (25)
6	5 (5.2)	87 (91.6)	2 (5)	1 (4)	0 (0)	1 (12.5)
7	2 (2.1)	89 (93.7)	0 (0)	1 (4)	0 (0)	1 (12.5)
8	1 (1.1)	90 (94.7)	0 (0)	1 (4)	0 (0)	0 (0)
9	1 (1.1)	91 (95.7)	1 (2.5)	0 (0)	0 (0)	0 (0)
10	1 (1.1)	92 (96.8)	0 (0)	0 (0)	0 (0)	1 (12.5)
11	1 (1.1)	93 (97.8)	0 (0)	1 (4)	0 (0)	0 (0)
12	0 (0)	93 (97.8)	0 (0)	0 (0)	0 (0)	0 (0)
13	2 (2.1)	95 (100)	0 (0)	1 (4)	0 (0)	0 (0)
Median (range)	3 (0–13)	—	3 (0–9)	2 (0–13)	2 (1–5)	5 (0–10)

*One horse underwent a second celiotomy at 13 days for worsening signs of toxemia (not shown).
— = Not applicable.

An intestinal resection was performed in 20 of 95 (21%) horses during the second celiotomy, which was the second intestinal resection for 14 horses. Cumulative anesthesia time was not different between horses with and without intestinal resection, but horses with large intestinal resections (n = 3) had significantly (P = 0.017) longer cumulative anesthesia times (median, 410 minutes; range, 335 to 450 minutes) than horses with small intestinal resections (n = 50; median, 290 minutes; range, 170 to 570 minutes). Beginning or established adhesion formation was observed in 7 horses during the second celiotomy. Twenty of 95 (21%) horses were euthanized during the second celiotomy. Reasons for euthanasia included septic peritonitis, intestinal necrosis that was not resectable, severe peritonitis with extensive fibrin deposition, and extensive intra-abdominal adhesion formation.

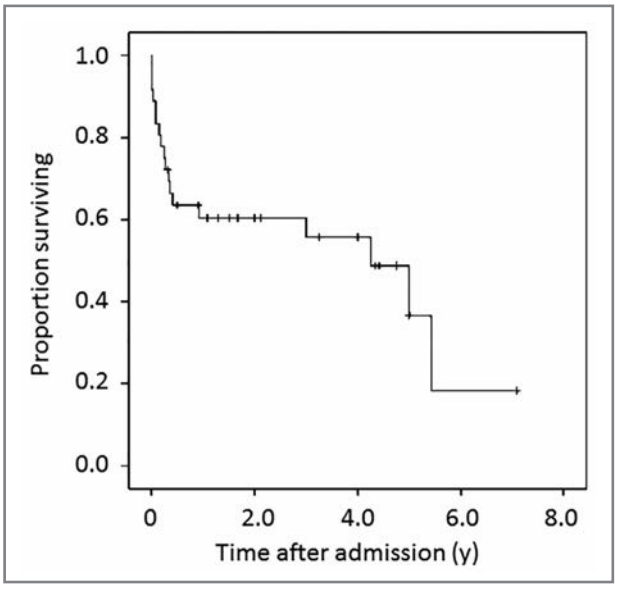

Figure 1—Kaplan-Meier survival curve of 95 horses undergoing 2 celiotomies for colic within a 14-day period (no follow-up information could be obtained for 2 horses that survived to hospital discharge). Tick marks along the survival curve indicate horses that were censored.

Outcome—Seventy-five of 95 (78.9%) horses were recovered from the second celiotomy, but 37 horses were euthanized before hospital discharge because of continued or recurrent ileus or colic (n = 24), subacute dysautonomia (grass sickness; 2), collapse (4), toxemia (3), peritonitis (2), poor long-term prognosis (1), and incision dehiscence (1). Thirty-eight of 95 (40%) horses survived to hospital discharge, and follow-up information was available for all but 2 horses. Twenty-seven of 93 (29%) horses survived > 3 months after hospital discharge, and 22 of 92 (23.9%) survived > 6 months after hospital discharge. All deaths within the first 6 months were associated with reoccurrence of colic, with the exception of 1 horse in which incisional dehiscence developed the same day the horse was discharged from the hospital. One horse had a third celiotomy because of colic 5 months after the first procedure. The horse subsequently developed an incisional hernia but continued to survive long term. This horse and 17 other horses were still alive at the last follow-up (median follow-up time, 3.25 years; range, 111 days to 7.1 years). The remaining 4 horses that survived > 6 months after hospital discharges were known to live an additional 3, 4.25, 5, and 5.42 years (**Figure 1**).

Significant differences between horses that did not survive and those that did survive to hospital discharge and to > 3 and > 6 months after hospital discharge were summarized (**Tables 2 and 3**). None of the clinical

Table 2—Significant ($P \leq 0.05$) differences in variables between horses that did not survive and those that did survive to hospital discharge and to > 3 and > 6 months after hospital discharge that underwent repeated celiotomy because of persistent gastric reflux, colic, gastric reflux and colic, and incisional complications.

	Survived to hospital discharge			Survived > 3 months after hospital discharge			Survived > 6 months after hospital discharge		
Variable	**Yes**	**No**	***P* value**	**Yes**	**No**	***P* value**	**Yes**	**No**	***P* value**
Heart rate (beats/min)									
Day 2 after first celiotomy	55 ± 15 n = 27	63 ± 15 n = 43	0.04	52 ± 15 n = 19	63 ± 15 n = 50	0.01	53 ± 15 n = 17	62 ± 15 n = 52	0.04
Day 1 after second celiotomy	52 (36–130) n = 33	64 (32–114) n = 34	0.02	48 (36–130) n = 23	64 (32–114) n = 42	0.01	48 (36–88) n = 19	64 (32–114) n = 46	0.006
Day 2 after second celiotomy	49 ± 11 n = 32	61 ± 18 n = 29	0.003	45 ± 10 n = 22	60 ± 17 n = 38	< 0.001	43 ± 7 n = 18	59 ± 17 n = 41	< 0.001
Gastric reflux (L)									
Day 2 after first celiotomy	0 (0–65) n = 34	2.0 (0–111) n = 31	0.005	—	—	—	—	—	—
Day 1 after second celiotomy	0 (0–32) n = 34	11.5 (0–97) n = 29	0.002	—	—	—	—	—	—
Day 2 after second celiotomy	0 (0–28) n = 33	0 (0–120) n = 24	0.001	0 (0–28) n = 23	0 (0–120) n = 32	0.02	—	—	—
Hospitalization (d)	13.5 (7–31) n = 38	6.0 (2–19) n = 56	< 0.001	13.5 (7–31) n = 38	6.5 (2–19) n = 64	< 0.001	14.5 (9–31) n = 22	7.0 (2–19) n = 69	< 0.001

Yes and no values are expressed as mean ± SD or median (range).
— = Nonsignificant data.
Heart rates on day 2 after first celiotomy and day 2 after second celiotomy were normally distributed; heart rates on day 1 after second celiotomy were not.

Table 3—Significant ($P \leq 0.05$) differences in categorical data between horses that did not survive and those that did survive to hospital discharge and to > 3 and > 6 months after hospital discharge that underwent repeated celiotomy because of persistent gastric reflux, colic, gastric reflux and colic, and incisional complications.

	Survived to hospital discharge				Survived > 3 months after hospital discharge				Survived > 6 months after hospital discharge			
Variable	**n**	**Yes**	**No**	***P* value**	**n**	**Yes**	**No**	***P* value**	**n**	**Yes**	**No**	***P* value**
Additional analgesia on first day after first celiotomy	84				82				82			
Yes		20 (23.8)	17 (20.3)	0.01		15 (18.3)	21 (25.6)	0.03		13 (15.9)	23 (28)	0.02
No		13 (15.4)	34 (40.5)			9 (11)	37 (45.1)			7 (8.5)	39 (47.6)	
Gastric reflux any time after second celiotomy	67				65				—			
Yes		7 (10.4)	21 (31.3)	< 0.001		6 (9.2)	22 (33.8)	0.01		—	—	—
No		28 (41.8)	11 (16.4)			19 (29.2)	18 (27.7)			—	—	
Colic on third day after second celiotomy	62				—				—			
Yes		4 (6.5)	11 (17.7)	0.009		—	—	—		—	—	—
No		31 (50)	16 (25.8)			—	—			—	—	
Exploration only during first celiotomy	—				89				—			
Yes		—	—	—		9 (10.1)	9 (10.1)	0.05		—	—	—
No		—	—			18 (20.2)	53 (59.6)			—	—	
Enterotomy during first celiotomy	—				88				87			
Yes		—	—	—		4 (4.5)	29 (33)	0.004		4 (4.6)	30 (34.5)	0.02
No		—	—			22 (25)	33 (37.5)			18 (20.7)	35 (40.2)	
Intestinal resection-anastomosis during first celiotomy	95				93				92			
Yes		19 (20)	38 (40)	0.079*		12 (12.9)	44 (47.3)	0.04		9 (9.9)	47 (51.1)	0.026
No		19 (20)	19 (20)			15 (16.1)	22 (23.7)			13 (14)	23 (25)	
Intestinal resection-anastomosis during first or second celiotomy	95				93				92			
Yes		20 (21.1)	43 (45.3)	0.021		13 (14)	49 (52.7)	0.015		9 (9.8)	52 (56.5)	0.004
No		18 (18.9)	14 (14.4)			14 (15)	17 (18.3)			13 (14.1)	18 (19.6)	

Values are expressed as number (%) of horses for each variable.
*Nonsignificant values included for comparison.
— = Nonsignificant data.

and laboratory variables measured at hospital admission differed between horses that survived and those that did not survive. Short-term survival rate (number of horses that survived to hospital discharge) was not influenced by the type of the primary lesion, the procedure performed (including comparison between different small intestinal anastomosis types), or the reason for performing repeated celiotomy. However, short-term survival rate but was significantly lower in horses with intestinal resections.

Intestinal resection and anastomosis during both surgeries was not different with regard to long-term survival rate (ie, number of horses that survived > 6 months after hospital discharge), compared to horses that had intestinal resection and anastomosis during only 1 surgery. For horses for which long-term follow-up was available, 13 of 31 horses (41.9%) without resection, 7 of 48 (14.8%) with resections during only 1 surgery, and 2 of 13 (15.4%) with resections during both surgeries survived to > 6 months. There were no significant differences in short-term survival rates (number of horses that survived to hospital discharge) or long-term survival rates (number of horses that survived > 3 or > 6 months after hospital discharge) between horses with large intestinal versus small intestinal resections. Although not explicitly investigated here, most owners of horses that survived to > 6 months after hospital discharge reported a return to previous function.

Incisional complications—Incisional infections were recorded for 15 horses before the second celiotomy, for 46 of 75 (61.3%) horses after the second celiotomy, and for 26 of 38 (68.4%) horses that survived to hospital discharge. Twelve horses, including 11 of 38 (28.9%) that survived for the short term, developed incisional hernias or dehiscence after the second celiotomy.

Discussion

Although repeated celiotomy has been described in several studies as part of the postoperative management of complications associated with initial colic surgery, few reports[12,13] have specifically investigated the indications, findings, and prognosis for horses undergoing repeated celiotomy. Only 1 other study[11] has focused on horses undergoing repeated celiotomy within 14 days after the first surgery.

Continued gastric reflux, often caused by postoperative ileus, is one of the most common reasons for death in horses following a single celiotomy,[4] and a second celiotomy is often the only viable treatment option if medical management fails. Indeed, similar to previous studies,[11,12] the main reason for horses in the present study to undergo repeated celiotomy was persistent gastric reflux, mainly secondary to postoperative ileus or anastomosis problems. Postoperative ileus is often initially treated conservatively, including watchful waiting and the administration of prokinetic drugs. Most horses in the present study received 1 or more prokinetic drugs prior to the second celiotomy. However, mechanical obstructions are unlikely to resolve with conservative management but are difficult to identify clinically. Although findings reported here suggested that the need for analgesia shortly after the first celiotomy and large volumes of gastric reflux might in-

dicate the presence of ileus, differentiating a functional from a mechanical obstruction remains challenging. Given that a second celiotomy is a recognized treatment option for postoperative ileus and is required for the correction of anastomotic complications, differentiation on clinical grounds might be less important. The second most common reason for horses in the present study to undergo repeated celiotomy was recurrent or persistent colic. Similar to considerations prior to a first abdominal surgery, persistent colic, particularly if unresponsive to analgesic drugs, ultimately requires surgical exploration of the abdomen, given that continued medical treatment is often not possible or the risk of a recurring or unrelated surgical lesion is deemed too high.

The best time for a horse to undergo repeated celiotomy with regard to outcome has not been determined. Anecdotally, opinions differ as to whether earlier intervention achieves better chances of success. Arguments for early intervention with a second celiotomy include reduction of ongoing daily costs for supportive therapy and avoiding the deleterious effects of continued small intestinal distension.[14–18] However, because there is a chance of spontaneous resolution of postoperative ileus and considering cost and morbidities associated with a second celiotomy, surgical intervention might be delayed for 48 to 72 hours, depending on surgeons' preference. In a study[19] investigating postoperative ileus after small intestinal surgery, mean duration of postoperative ileus was 64 ± 58 hours (median, 40 hours; range, 1 to 240 hours). Unfortunately, the study[19] did not report the number of horses that were euthanized because of persistent ileus or the reasons why a second celiotomy was undertaken in some horses.[19] In the study reported here, no difference in time between surgeries was detected between horses that survived and horses that did not survive. The median time of 3 days between celiotomies probably reflects the hope that gastric reflux might cease given enough time. Most second surgeries performed earlier than 3 days after the first celiotomy were associated with either colic or other factors in addition to gastric reflux, shifting the balance in favor of an earlier second celiotomy. In cases where the second celiotomy was undertaken after 5 to 7 days, horses frequently appeared to recover uneventfully until an unexpected complication arose.

Disappointingly, gastric reflux only resolved in 25% of horses that underwent repeated celiotomy for this reason and persistent or recurring gastric reflux or colic were the reasons for euthanasia in 65% (24/37) of horses that did not survive to hospital discharge. Despite this, a second celiotomy because of persistent gastric reflux was not associated with a worse short-term prognosis, probably highlighting the fact that other reasons for horses to undergo repeated celiotomy, such as persistent colic or incisional complications, often do not offer a good prognosis either. A benefit of a second celiotomy is the ability to establish the causes of complications early and accurately and to identify horses with a poor or grave prognosis.

Short-term survival rate in horses undergoing repeated celiotomy has consistently been lower than that for horses only undergoing a single celiotomy.[9,11] This is not surprising, considering that a second celiotomy is only considered for horses that have complications during the recovery period from the first celiotomy. Significant differences between horses that survived and horses that did not survive were identified for heart rates on the second day after the first celiotomy and the first and second day after the second celiotomy. Lower heart rates have been associated with better outcomes in many studies,[6,20–22] and it is reassuring that this simple clinical variable remains of prognostic value. Presence of gastric reflux on day 1, 2, or 3 after the second celiotomy and colic on the third day after the second celiotomy was more common in horses that did not survive, confirming that those were the usual reasons for discontinuation of further treatment. Fewer horses survived to > 3 and > 6 months after hospital discharge that had an intestinal resection performed during the first or both surgeries. The type of anastomosis was, in contrast to other studies,[8,23,24] not associated with a change in short- or long-term outcome.

Only 22 of 92 (23.9%) horses in the present study survived to > 6 months after hospital discharge. This finding is similar to 2 earlier studies that found long-term survival rates of 20% (> 12 months)[12] and 22.2% (> 12 months).[11] Recurrent colic was the reason for euthanasia after hospital discharge in all but 1 horse. Horses undergoing repeated celiotomy have been shown to have an increased risk for postoperative colic[7] and adhesion formation.[4] It is likely that adhesion formation contributed to recurrent colic and death in these horses. A higher prevalence of colic after hospital discharge and adhesion formation has been reported for horses that had undergone intestinal resection,[4] which could correspond with the decreased long-term survival rate in horses with intestinal resections observed in the present study. On the other hand, another study[13] found no relationship between intestinal resection and intra-abdominal adhesion formation. The authors of that study[13] suggested that not the procedure as such, but exposure and handling of adjacent intestine predisposes to adhesion formation. In the present study, anesthesia and surgery time, and therefore presumably the time span of intestinal handling and exposure, was not different between horses with and without intestinal resection and anastomosis. Therefore, inflammation or ischemia prompting intestinal resection might be a more likely predisposing factor in this population. It is possible that the cumulative trauma of 2 surgeries in close succession, in conjunction with intestinal compromise, added to the risk of adhesion formation and ultimately affected long-term survival rate. Whether a subjective grading system for intestinal viability[25] could reduce the need for intestinal resection and positively influence long-term outcome remains unknown. Interestingly, few horses that survived to > 6 months after hospital discharge developed recurrent colic episodes or any other compromise of well-being. This could suggest that either no intra-abdominal adhesions were present or that they were of little clinical relevance.

Similar to previous findings,[5] a high incidence of incisional infections was encountered, which may have even been underestimated given that this information was obtained retrospectively from medical records. A

significantly higher number of horses with incisional infection developed incisional hernias, compared with hernia formation in horses with an incisional infection after a single celiotomy (19.3% vs 2.6% without wound infection).[4] Incisional infection and a second celiotomy have both been identified as risk factors for incisional hernia formation,[4,26,27] and it is likely that their effects are additive. The high rate of incisional complications and the potential requirement for additional surgical treatment should be factored into the discussion with horse owners opting for a second celiotomy. The use of a paramedian incision at the second celiotomy site has been proposed as a method of reducing incisional complications[28] and could be considered as an alternative to use of the original wound. Because of the almost exclusive use of the same median incision, this could not be investigated in the present study. The only horse in the present study with a second paramedian approach developed infection of both incisions with subsequent formation of a large hernia. Experimentally, a second celiotomy after 72 hours with a ventral midline incision results in similar incisional healing and tensile strength as a second celiotomy with a right ventral paramedian incision.[29]

Although the present study provided some insight into short- and long-term prognosis and factors influencing outcome, several questions in regard to horses undergoing early repeated celiotomy remain unanswered. Queries that need to be addressed in the future include determining the optimal timing for a second celiotomy, comparison of medical versus surgical management of horses with postoperative gastric reflux (keeping in mind that it is often impossible to determine the reason for persisting gastric reflux), and benefits of a paramedian approach in the clinical setting.

The prognosis for horses undergoing repeated celiotomy within 14 days of the first celiotomy is guarded, with only 24% of horses in the present study surviving to > 6 months after hospital discharge. Intestinal resection and anastomosis influences the long-term prognosis negatively. The rate of incisional complications is high, and incisional hernias develop in close to a third of short-term survivors.

a. IBM SPSS, version 19, IBM United Kingdom Ltd, Portsmouth, Hampshire, England.

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