Survival and complication rates in 300 horses undergoing surgical treatment of colic. Part 2: Short-term complications

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Keywords: horse; colic; laparotomy; complications; short-term

Summary

***Reasons for performing study*: Few studies have assessed short- and long-term complication rates of horses following surgical treatment of colic, a potentially fatal condition. Complications can lead to patient discomfort and increased costs; knowledge of predisposing factors may help to reduce complication rates.**

***Objectives*: To document and analyse short-term complications in 300 horses undergoing colic surgery, and to assess some of the possible predisposing factors.**

***Methods*: History, clinical findings, surgical findings and procedures, and post operative treatments of 300 consecutive surgical colic cases (1994–2001) were reviewed. Comparisons among groups of discrete data were made using chi-squared or Student's *t* tests as appropriate.**

***Results*: Short-term complications in 227 horses following a single laparotomy included colic/pain (28.2%), incisional drainage or infection (26.9%), post operative ileus (13.7%), severe endotoxaemic shock (12.3%), jugular thrombophlebitis (7.5%), septic peritonitis (3.1%) and colitis/diarrhoea (2.2%). Horses with small bowel obstruction had a higher rate of post operative ileus than those with large bowel obstruction. Rates of post operative pain and shock were higher in horses with small colon rather than large colon obstruction, and in those that had an ischaemic rather than a simple obstruction. The rate of wound complications increased with increasing total plasma protein concentration at admission. Horses that had a repeat laparotomy had a higher rate of wound complications compared to those that had a single laparotomy. Application of a stent bandage was associated with a higher rate of wound complications than if no stent was applied; however, application of an incise drape over the wound for recovery was associated with a lower rate of wound complications than for horses that had no protective covering of the wound.**

***Conclusions*: The most common short-term post operative complications following colic surgery were pain, incisional drainage, ileus, endotoxaemiac shock and jugular thrombophlebitis. Some factors that appeared to predispose to these complications were identified. Although many of these factors related to the underlying disease process, a number of factors, including surgical techniques, were identified that might be amenable to modification.**

***Potential relevance*: Prospective studies to assess the effects of modifying these factors on survival rates should be performed.**

Introduction

Despite the substantial volume of literature on various aspects (including short-term survival rates) of colic in the horse, there are surprisingly few studies that have assessed the short- and long-term complication rates in horses following surgical treatment of colic (Edwards and Hunt 1985; Hunt *et al.* 1986; Kobluk *et al.* 1989; Blikslager *et al.* 1994; Honnas and Cohen 1997; Freeman *et al.* 2000; Roussel *et al.* 2001; French *et al.* 2002). Mair and Smith (2005a) analysed short-term survival rates of 300 horses undergoing surgical treatment for acute colic; here, short-term complications in the same 300 horses are reviewed. Long-term complication and survival rates are reported elsewhere (Mair and Smith 2005b).

Complications of surgery lead to patient discomfort, prolonged hospitalisation times and increased costs. A further objective of this study was to assess some of the factors (both pre-, intra- and post operative) that might predispose horses to such complications. Knowledge of such factors should, hopefully, lead to techniques and procedures that reduce the rates of these complications.

Materials and methods

Case records of 300 horses that had exploratory laparotomies at the Bell Equine Veterinary Clinic for acute colic between 1994 and 2001 were reviewed. Details of the horses and methods of data collection have been reported by Mair and Smith (2005a). Incomplete records were discarded.

Definitions and diagnoses

Short-term complications were defined as those occurring in the immediate post operative period (from the time of recovery from anaesthesia until the time of discharge from the hospital). Details of these complications were recovered from the case notes.

Post operative ileus was defined as a functional complication of surgery in horses that had reflux greater than 2 l through a nasogastric tube and did not have a mechanical obstruction. A mechanical obstruction was diagnosed at necropsy or at a repeat surgery. This definition is similar to that used by Freeman *et al.* (2000), except for the inclusion of horses with anterior enteritis (duodenitis-proximal jejunitis) in the current study.

Signs of abdominal pain after surgery (lying down for excessive periods, inappetence, restlessness, flank-watching, repeated stretching as if to urinate, kicking at the abdomen,

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[Paper received for publication 24.03.04; Accepted 13.05.04]

TABLE 1: Short-term post operative complications in 227 horses following a single laparotomy

Complication	No.	%	95% CI
Colic/pain	64	28.2	0.22–0.34
Incisional complications	61	26.9	0.21–0.33
Ileus	31	13.7	0.09–0.19
Endotoxaemic shock	28	12.3	0.08–0.17
Jugular thrombophlebitis	17	7.5	0.04–0.11
Septic peritonitis	7	3.1	0.01–0.06
Colitis	5	2.2	0.01–0.05
Hyperlipaemia	2	0.9	0.00–0.03
Myopathy	1	0.4	0.00–0.02
Laminitis	1	0.4	0.00–0.02

sweating, pawing, rolling) were considered abnormal, and classified as post operative pain.

Post operative septic peritonitis was diagnosed on the basis of a combination of clinical signs of depression, pyrexia, endotoxaemic shock and variable abdominal pain, in association with abnormal peritoneal fluid (total nucleated cell count >100 x 10^9/l with cytological evidence of free or phagocytosed bacteria).

Post operative shock was defined as a worsening cardiovascular state after surgery that persisted >24 h and was associated with persistent tachycardia (>60 beats/min), congested mucous membranes, prolonged capillary refill time (>2 secs), leucopenia and neutropenia and a rising packed cell volume (PCV) despite maintenance fluid therapy.

Post operative colitis/diarrhoea was defined as persistent diarrhoea >24 h duration associated with pyrexia, with or without concurrent leucopenia and neutropenia.

Wound drainage was defined as the presence of serous or serosanguinous discharge from the wound associated with local oedema but without heat or pain; and wound infection as the presence of purulent discharge associated with swelling, heat and pain around the skin incision.

Diagnosis of jugular vein thrombophlebitis was based on clinical signs (swelling over the affected vein, with or without occlusion of the vein) and results of ultrasonographic evaluation. Septic thrombophlebitis was diagnosed if there was heat and pain on palpation, fever, neutrophilic leucocytosis and ultrasonographic evidence of cavitation within the thrombus.

Statistics

Data were entered into a statistics programme (Minitab for Windows Release 13)[1]. Descriptive statistics (mean ± s.d., median and range) were generated for continuous data. The evaluation of differences between survivors and nonsurvivors was undertaken using a Student's *t* test for continuous variables and a chi-squared test for categorical variables. The hypothesis was that pre- and intraoperative factors would affect the short-term complication rates following colic surgery. Significance was set at P<0.05, and odds ratios (OR) and 95% confidence intervals (95% CI) were calculated for categorical data.

Results

Short-term complications in horses undergoing a single exploratory laparotomy

The rates of short-term post operative complications in 227 horses that recovered after a single laparotomy (excludes horses that had a repeat laparotomy) are summarised in Table 1. Post operative ileus was recorded in 31 horses (13.7%). The mean and median duration of gastric reflux in these cases was 2.8 ± 1.9 days and 2.0 days (range 1.0–8.0 days), respectively. Incisional complications were classified as drainage (nonpainful serous or purulent discharge) (n = 54; 23.8%) and wound infection (purulent discharge with local wound heat and pain) (n = 7; 3.1%). Jugular vein thrombophlebitis was aseptic in 16 cases (7.0%) and septic in one (0.4%) (based on clinical, ultrasonographic and cytological features).

Association between pre- and intraoperative findings and short-term complications

Two hundred and fifty-two horses recovered from anaesthesia after a single surgery (including those that subsequently had a second laparotomy, but excluding 2 pre-existing septic peritonitis cases).

Post operative ileus: Post operative ileus was recorded in 46/252 horses (18.2%). Horses with gastric reflux (>2 l) at admission had a significantly higher rate of post operative ileus (26/60, 43.3%) than those without reflux (16/141, 11.4%; OR 5.97; 95% CI 2.71–13.27; P<0.0003). Horses with small intestinal obstruction had a significantly higher rate of post operative ileus (42/123, 34.2%) than those with a large intestinal obstruction (4/129, 3.1%; OR 16.2; 95% CI 5.52–63.95; P<0.0002). The prevalence of post operative ileus in horses with small intestinal obstruction of 34.2% was reduced to 31.9% (37/116) if cases of anterior enteritis (duodenitis-proximal jejunitis) were excluded. Horses with small intestinal obstruction that developed post operative ileus had a significantly lower short-term survival rate (21/42, 50.0%) than those without ileus (73/81, 90.1%; OR 0.11; 95% CI 0.04–0.31; P<0.0007). When all 252 horses (small and large intestinal obstructions) were considered, the short-term survival rate for horses developing post operative ileus (22/46, 47.8%) was significantly lower than for those without ileus (187/206, 90.8%; OR 0.09; 95% CI 0.04–0.21; P<0.0003).

The prevalence of post operative ileus associated with different small intestinal lesions is shown in Table 2. There was no significant difference in the incidence of post operative ileus between simple and ischaemic obstructions of the small intestine or between animals that had small intestine resected or not. However, when all 252 horses (small and large intestinal obstructions) were analysed, the rate of ileus was significantly higher in horses that had an intestinal resection (28/78, 35.9%) compared with those that did not (18/174, 10.3%; OR 4.85; 95% CI 2.35–10.1; P<0.0001), and in horses that had ischaemic bowel left in the abdomen (7/18, 38.9%) compared with those that did not (39/234, 16.7%; OR 3.18; 95% CI 0.98–9.60; P = 0.02).

The highest rate of post operative ileus was associated with the side-to-side jejunojejunostomy (53.8%). The rate of post operative ileus was significantly lower in horses that had colonic evacuation performed (23/172, 13.4%) (including horses with both small intestinal and large intestinal diseases) than in those that did not (21/82, 25.6%; OR 0.45; 95% CI 0.22–0.92; P = 0.02).

Post operative pain

Post operative pain was recorded in 81/252 horses (32.1%). Significant differences in the rate of post operative pain were identified with respect to the following variables at admission; attitude, heart rate, capillary refill time and gut sounds (Table 3).

TABLE 2: Prevalence rates of post operative ileus (POI) in 123 horses with small intestinal lesions

Lesion	n	No. (%) developing POI	95% CI
Strangulation by pedunculated lipoma	32	14 (43.7%)	0.26–0.62
Simple obstruction by mesenteric lipoma	2	0	0.00–0.77
Volvulus	12	3 (25.0%)	0.05–0.57
Incarceration in mesenteric rent/band	6	2 (30.0%)	0.04–0.78
Incarceration in epiploic foramen	10	3 (30.0%)	0.07–0.65
Incarceration in inguinal, umbilical or ventral hernia	7	3 (42.8%)	0.10–0.81
Obstruction by omental or mesenteric adhesions	10	2 (20.0%)	0.03–0.56
Jejunal intussusception	1	0	0.00–0.95
Ileocaecal intussusception/obstruction	13	3 (23.1%)	0.05–0.54
Jejunal or Ileal impaction	11	2 (18.2%)	0.02–0.52
Obstruction by mesenteric abscess	1	0	0.00–0.95
Anterior enteritis	7	5 (71.4%)	0.29–0.96
Focal obstruction by inflammatory bowel disease or lymphoma	5	1 (20.0%)	0.01–0.71
Ileus without discrete/physical obstruction	6	4 (66.7%)	0.22–0.96

Horses with post operative gastric reflux had a significantly higher rate of post operative pain (31/60, 51.7%) than those without reflux (42/141, 29.8%; OR 2.52; 95% CI 1.29–4.91; P = 0.003). There was no significant difference in the prevalence of post operative pain relative to the length of surgery. The rate of post operative pain was significantly higher for small intestinal obstructions compared with large intestinal obstructions (Table 4). Post operative pain was more common with ischaemic obstructions (46/100, 46.0%) than simple obstructions (35/152, 23.0%; OR 2.85; 95% CI 1.59–5.10; P = 0.0001).

The rate of post operative pain was significantly higher in relation to the following: intestinal resection (41/78, 52.6%) compared to no resection (40/174, 23.0%; OR 3.71; 95% CI 2.02–6.81; P<0.0003); small intestinal distension at surgery (62/148, 41.9%) compared to none (19/104, 18.3%; OR 3.23; 95% CI 1.72–6.91; P<0.0008); ischaemic intestine left in the abdomen (11/18, 61.1%) compared to not (70/234, 29.9%; OR 3.68; 95% CI 1.24–11.63; P = 0.006); post operative ileus (31/46, 67.4%) compared to no ileus (50/206, 24.3%; OR 6.45; 95% CI 3.07–13.85; P<0.0002); and post operative peritonitis (6/7, 85.7%) compared to no peritonitis (75/245, 30.6%; OR 13.6; 95% CI 1.59–629.12; P = 0.002).

Post operative peritonitis

Seven of the 252 horses (2.8%) that recovered from surgery (excluding 2 with pre-existing peritonitis of unknown cause) were diagnosed with post operative peritonitis. One of the 7 cases (14.3%) was considered to have serious peritoneal contamination at the time of surgery. The rate of post operative peritonitis in horses that received intraperitoneal antibiotics (3/10, 30%) was not significantly different to the rate in those not given these antibiotics (4/242, 1.7%; OR 25.5; 95% CI 3.01–177.45; P<0.0001); nor in horses that had an abdominal drain (3/12, 25.0%) compared to those that did not (4/240, 1.7%; OR 19.67; 95% CI 2.42–131.73; P<0.0002).The rate of post operative peritonitis was significantly higher in horses that demonstrated post operative pain (6/81, 7.4%) compared with those that showed no pain (1/171, 0.6%; OR 13.6; 95% CI 1.59–629.12; P = 0.002). The short-term survival rate for horses with post operative peritonitis (5/7, 71.4%) was not statistically different from that of horses that did not develop peritonitis (204/245, 83.3%; OR 0.50; 95% CI 0.08–5.47; P = 0.41).

TABLE 3: Association between variables at admission and post operative pain (POP) in 252 horses

	n	No. (%) developing POP	95% CI
Attitude at admission			
Normal	63	9 (14.3%)	0.07–0.25
Painful	105	31 (29.5%)	0.21–0.39
Depressed	84	41 (48.8%)	0.38–0.60
Heart rate (beats/min)			
30–39	23	2 (8.7%)	0.01–0.28
40–49	82	16 (19.5%)	0.12–0.30
50–59	49	15 (30.6%)	0.18–0.45
60–69	51	20 (39.2%)	0.26–0.54
70–79	18	8 (44.5%)	0.21–0.69
80–89	21	13 (61.9%)	0.38–0.82
>90	8	7 (87.5%)	0.47–0.99
Capillary refill time (secs)			
<2	133	17 (12.8%)	0.08–0.20
2–3	99	22 (22.2%)	0.14–0.32
>3	20	7 (35.0%)	0.15–0.59
Nature of gut sounds			
Normal	41	8 (19.5%)	0.09–0.35
Reduced	110	22 (20.0%)	0.13–0.29
Absent	101	51 (50.5%)	0.40–0.61

TABLE 4: Association between the site of intestinal obstruction and post operative pain (POP) in 252 horses

Site	n	No. (%) developing POP	95% CI
Small intestine	123	53 (43.1%)	0.34–0.52
Caecum	12	6 (50.0%)	0.21–0.79
Large colon	108	19 (17.6%)	0.10–0.26
Small colon	9	3 (33.3%)	0.07–0.70

Post operative shock

Severe post operative shock was recorded in 35 of 252 horses (13.9%). Rates showed a statistically significant difference relative to the duration of colic at admission (Table 5), increasing with increasing duration of colic, but then declining after 48 h. Horses admitted with intermittent colic had a lower rate of post operative shock (9/114, 7.9%) than those with continuous colic (26/138, 18.8%; OR: 0.37; 95% CI 0.15–0.86; P = 0.012). Statistically significant differences were found in the rate of shock relative to the following variables at admission: severity of colic, attitude, heart rate, capillary refill time, PCV, total plasma protein (TPP) and gut sounds (Table 6).

Rates were higher in horses with abnormal (16/70, 22.9%) than normal peritoneal fluid (6/113, 5.3%; OR 5.28; 95% CI 1.82–17.29; P = 0.0004), and gastric reflux at admission (16/60, 26.7%) compared with no reflux (15/141, 10.6%; OR 3.05; 95% CI 1.29–7.21; P = 0.004).

Rate of shock was significantly higher for horses with small intestinal lesions (26/123, 21.1%) compared with large intestinal lesions (9/129, 7.0%; OR 3.57; 95% CI 1.53–9.05; P = 0.001), and ischaemic lesions (26/100, 26.0%) compared with simple obstructions (9/152, 5.9%; OR 5.58; 95% CI 2.37–14.17; P<0.0007). Ischaemic lesions of small intestine gave a significantly higher rate of post operative shock than simple obstructions of small bowel or lesions of large bowel (Table 7). The rate was significantly higher for horses with small intestinal distension at

TABLE 5: Rates of post operative shock (POS) associated with duration of colic in 252 horses

Duration of colic (h)	n	No. (%) developing POS	95% CI
0–6	48	1 (2.1%)	0.00–0.11
6–12	100	18 (18.0%)	0.11–0.27
12–24	66	9 (13.6%)	0.06–0.24
24–48	29	7 (24.1%)	0.10–0.43
>48	9	0	0.00–0.28

TABLE 6: Association between variables at admission and post operative shock (POS) in 252 horses

	n	No. (%) developing POS	95% CI
Severity of pain score			
1 (mild)	60	9 (15.0%)	0.07–0.26
2 (moderate)	128	11 (8.6%)	0.04–0.15
3 (severe)	64	15 (23.4%)	0.14–0.36
Attitude			
Normal	63	1 (1.6%)	0.00–0.08
Painful	105	18 (17.1%)	0.10–0.26
Depressed	84	16 (19.0%)	0.11–0.29
Heart rate (beats/min)			
30–39	23	1 (4.3%)	0.00–0.22
40–49	82	4 (4.9%)	0.01–0.12
50–59	49	7 (14.3%)	0.01–0.12
60–69	51	9 (17.6%)	0.08–0.31
70–79	18	4 (22.2%)	0.06–0.48
80–89	21	5 (23.8%)	0.08–0.47
>90	8	5 (62.5%)	0.24–0.91
Capillary refill time (secs)			
<2	133	8 (6.0%)	0.03–0.11
2–3	99	18 (18.2%)	0.11–0.27
>3	20	9 (45.0%)	0.23–0.68
PCV (%)			
<30	37	2 (5.4%)	0.01–0.18
30–39	112	10 (8.9%)	0.04–0.16
40–49	70	10 (14.3%)	0.07–0.25
>50	21	11 (52.4%)	0.30–0.74
Total plasma protein (g/l)			
<60	24	4 (16.7%)	0.05–0.37
60–69	86	6 (7.0%)	0.03–0.15
70–79	64	10 (15.6%)	0.08–0.27
80–89	45	6 (13.3%)	0.05–0.27
>90	19	7 (36.8%)	0.16–0.62
Nature of gut sounds			
Normal	41	3 (7.3%)	0.02–0.20
Reduced	110	6 (5.5%)	0.02–0.11
Absent	101	26 (25.7%)	0.17–0.35

the time of surgery (28/146, 19.2%) compared with those without (7/104, 6.7%; OR 3.29; 95% CI 1.32–9.27; P = 0.005).

Significantly higher rates of shock were recorded in horses that developed post operative ileus (18/46, 39.1%) than those that did not (17/206, 8.3%; OR 7.15; 95% CI 3.05–16.60; P<0.0004), and post operative pain (33/81, 40.7%) than those that did not (2/171, 1.2%; OR 58.09; 95% CI 13.77–507.85; P<0.0002). The short-term survival rate for horses that developed post operative shock (13/35, 37.1%) was significantly lower than for horses that did not develop shock (196/217, 90.3%; OR 0.06; 95% CI 0.03–0.16; P<0.0008).

Post operative colitis/diarrhoea

Eight of 252 horses (3.2%) were diagnosed with colitis in the post operative period. Survival rate was 75.0% (6/8), which was not statistically different to that of horses without post operative colitis (203/244, 83.2%; OR 0.61; 95% CI 0.10–6.36; P = 0.54).

TABLE 7: Incidence of post operative shock (POS) in 252 horses associated with the site and nature of the obstruction

Site and nature	n	No. (%) developing POS	95% CI
Simple obstruction; small bowel	50	7 (14.0%)	0.06–0.27
Ischaemic obstruction; small bowel	73	19 (26.0%)	0.16–0.38
Simple obstruction; large bowel	102	2 (2.0%)	0.00–0.07
Ischaemic obstruction; large bowel	27	7 (25.9%)	0.11–0.46

TABLE 8: Association between total plasma protein concentration and gut sounds at admission with wound complications (WC) in 238 horses

	n	No. (%) developing a WC	95% CI
Total plasma protein (g/l)			
<60	24	3 (12.5%)	0.03–0.32
60–69	86	20 (23.3%)	0.15–0.34
70–79	64	21 (32.8%)	0.22–0.46
80–89	45	17 (37.8%)	0.24–0.53
>90	19	9 (47.4%)	0.24–0.71
Nature of gut sounds			
Normal	41	8 (19.5%)	0.09–0.35
Reduced	110	44 (40.0%)	0.31–0.50
Absent	101	21 (20.8%)	0.13–0.30

Jugular vein thrombophlebitis

Jugular vein thrombophlebitis was recorded in 21 of the 252 horses (8.3%). The rate of this complication was significantly higher in horses demonstrating post operative pain (12/81, 14.8%) compared with those that did not (9/171, 5.3%; OR 3.13; 95% CI 1.15–8.79; P = 0.01), and in horses that developed post operative shock (7/35, 20.0%) compared with those that did not (14/217, 6.5%; OR 3.63; 95% CI 1.13–10.56; P = 0.007).

Wound complications

Early complications with the abdominal incision were recorded in 73/252 horses (29.0%) (drainage in 63 and infection in 10 horses). Significant differences in rates were found in relation to TPP concentration and the nature of gut sounds at admission (Table 8). The rates of wound complications were significantly different in relation to the following: administration of intraperitoneal heparin (29/137, 21.2%) compared with no heparin (44/115, 38.3%; OR 0.43; 95% CI 0.24–0.78; P = 0.003); intraperitoneal contamination at surgery (7/11, 63.6%) compared with no contamination (66/241, 27.4%; OR 4.64; 95% CI 1.13–22.18; P = 0.01); intraperitoneal antimicrobial drug administration (6/10, 60.0%) compared with no antimicrobial (67/242, 27.7%; OR 3.92; 95% CI 0.89–19.36; P = 0.03); repeat laparotomy (12/27, 44.4%) compared with single laparotomy (61/225, 27.1%; OR 2.15; 95% CI 0.86–5.23; P = 0.06); administration of antimicrobial drug into the wound (55/208, 26.4%) compared with not (18/44, 40.1%; OR 0.52; 95% CI 0.25–1.09; P = 0.06); dissection of *linea alba* prior to closure (13/23, 56.5%) compared with not (60/229, 26.2%; OR 3.66; 95% CI 1.39–9.81; P = 0.002); application of a stent bandage (21/24, 50.0%) compared with not (61/228, 26.7%; OR 19.16; 95% CI 5.37–102.54; P<0.0002); application of an incise drape over the incision (16/102, 15.7%) compared with not

(57/150, 38.0%; OR 0.30; 95% CI 0.15–0.59; P = 0.0001); development of post operative peritonitis (6/7, 85.7%) compared with no peritonitis (67/245, 27.3%; OR 15.94; 95% CI 1.86–737.17; P = 0.001); and development of jugular vein thrombophlebitis (11/21, 52.4%) compared with no thrombophlebitis (62/231, 26.8%; OR 3.00; 95% CI 1.09–8.27; P = 0.013).

The short-term survival rate for horses that developed incisional complications (70/73, 95.9%) was significantly higher than for those that did not develop wound problems (139/179, 77.7%; OR 6.71; 95% CI 2.02–34.92; P = 0.0005).

Other post operative complications

Abortion was not recorded post operatively. Laminitis was diagnosed in the immediate post operative period in one horse that had an ileal impaction. This horse also developed post operative ileus and pain.

Discussion

Only univariable analyses were undertaken in this study and confounding factors that could affect the associations between pre- and intraoperative variables and post operative complications have not been assessed. This must be taken into consideration when evaluating the results. However, the most common post operative complications were ileus (18.2%), persistent pain (32.1%) and endotoxaemic shock (13.9%), and all of these appeared to have a significant effect on survival/death rates (Mair and Smith 2005a).

The types and nature of the post operative complications identified here were similar to those in previous reports (Ducharme *et al.* 1983; Hunt *et al.* 1986; Phillips and Walmsley 1993; Freeman *et al.* 2000; French *et al.* 2002; Proudman *et al.* 2002), although there were differences in the prevalence of the complications between different studies. Some of this variability may be due to the trend towards earlier referral and surgical intervention that has occurred in the last 10 years. It is also interesting to note that the main causes of post operative deaths varied between studies. The most common causes of death in 3 large retrospective studies included anastomotic leakage (MacDonald *et al.* 1989), septic peritonitis (Phillips and Walmsley 1993) and shock (Ducharme *et al.* 1983). In the current study, post operative pain was identified as the most common reason for euthanasia. In some instances the decision to perform euthanasia in these cases, rather than proceeding to a second laparotomy, was based on economic restraints.

Post operative ileus occurred in 18.2% of the horses that recovered from surgery, and the rate of ileus was significantly higher in horses with small intestinal lesions (34.2%) than those with large intestinal lesions (3.1%). The prevalence of post operative ileus in previously reported case series is summarised in Table 9. When compared with other published studies, it appears that there was a higher prevalence of post operative ileus in horses in the present series. However, this is probably at least partly explained by criteria used to define post operative ileus. The definition used in the present study was similar to that of Freeman *et al.* (2000), but the latter study excluded horses with anterior enteritis (duodenitis-proximal jejunitis), whereas the present study included 7 such cases. There is also a substantial difference in the death rates for post operative ileus recorded in different studies, and in the rate of post operative ileus in horses that die post operatively. Differences in the management of cases between different clinics may partly explain some of these inconsistencies. This aspect of treatment warrants further investigation. Many of the fatal cases of post operative ileus recorded in the present series were subjected to euthanasia at the owners' request for economic reasons, and it is likely that the death rate from post operative ileus could have been reduced if treatment had been maintained for longer. Such factors are impossible to control in clinical cases and it is impossible to compare these influences between different studies.

TABLE 9: Prevalence and death rates of post operative ileus (POI)

Reference	Prevalence (% cases at risk)	Prevalence of fatal POI (% cases at risk)	Deaths from POI (% all deaths)	Deaths in horses with POI (% affected)
Ducharme *et al.* 1983	-	3.6[a]	9.8[a]	-
Ducharme *et al.* 1983	-	8.8[b]	23.5[b]	-
Edwards and Hunt 1985	16[c]	14[c]	-	86[c]
Hunt *et al.* 1986	14[c]	-	43[a]	86[a]
MacDonald *et al.* 1989	16[d]	8.6[d]	17[d]	52[d]
DeGeest *et al.* 1991	12[e]	-	25[e]	50[e]
van der Velden and Klein 1993	27[e]	7[f]	-	25[f]
van der Velden and Klein 1993	40[g]	10[g]	36[fg]	25[g]
Proudman *et al.* 2002a	9.6[a]	2.9[a]	8.6[a]	30.0[a]
Phillips and Walmsley 1993	-	4.7[e]	25[a]	-
Blikslager *et al.* 1994	47[e]	2.7[a]	40[a]	13[a]
Vachon and Fischer 1995	16[h]	-	-	-
Freeman *et al.* 2000	10[e]	1.4[e]	9[e]	14[e]
Present study	18.2[a]	9.5[a]	55.8[a]	52.2[a]
Present study	34.1[e]	17.1[e]	72.4[e]	50.0[e]

Data have been corrected as needed to relate the short-term (hospitalisation) period to horses that recovered from general anaesthesia. [a]All colics, ileus only; [b]all colics, ileus and gastric rupture combined; [c]small intestine only excluding ileus caused by devitalised bowel or peritonitis; [d]small intestinal resection and anastomosis only; [e]small intestinal surgery only; [f]small intestinal surgery with prophylactic cisapride; [g]small intestinal surgery without cisapride; [h]small intestinal surgery for strangulation in epiploic foramen.

There was no significant difference in the rate of ileus development between strangulating and simple small intestinal obstructions. These findings are broadly in agreement with those of Blikslager *et al.* (1994) and Roussel *et al.* (2001). However, other studies have recorded a clear association between strangulation of small intestine and the development of post operative ileus (Edwards and Hunt 1985; Freeman *et al.* 2000). French *et al.* (2002) demonstrated an increased risk of post operative ileus associated with high PCV and with pedunculated lipoma obstruction. Although no specific association with pedunculated lipoma obstruction was shown in the current study, it is noteworthy that strangulation of small intestine by a pedunculated lipoma was a commonly recorded lesion associated with the development of post operative ileus (excluding cases of anterior enteritis and pre-existing ileus). Many cases of strangulation of intestine by pedunculated lipomas occur in geriatric horses, and the duration of obstruction is often relatively long because such horses may fail to show signs of pain as readily as younger horses. This longer duration of obstruction may result in a higher prevalence of post operative ileus. Pelvic flexure enterotomy was shown in one study to reduce the risk of post operative ileus (Roussel *et al.* 2001), and a similar finding was demonstrated in the current study. This suggests that evacuation of the colon should be considered as a routine procedure in all horses believed to be at risk of developing post operative ileus. However,

there may have been confounding variables in this study, as well as in the study of Roussel *et al.* (2001), that may have influenced these results. Further prospective studies in this area are necessary.

The development of post operative endotoxaemic shock was an important complication in the present series, and was associated with a high nonsurvival rate. The duration of colic appeared to affect the risk of post operative shock. This highlights the importance of early diagnosis in reducing the rates of complications after surgery. Morton and Blikslager (2002) also found evidence of a reduced survival rate in horses showing evidence of shock in the immediate post operative period.

Jugular vein thrombophlebitis was recorded in 21/252 horses (8.3%). The incidence of this complication was significantly higher in horses that developed post operative pain and shock. Horses with endotoxaemia develop hypercoagulable states (Henry and Moore 1991; Prasse *et al.* 1993), and it is likely that this has a major influence on the development of jugular vein thrombosis. Thrombophlebitis occurs almost exclusively at the site of i.v. catheter placement and the presence of a catheter acts as a focus for thrombosis in endotoxaemic horses (Morris 1991). It seems reasonable to assume that horses affected by post operative shock are in an endotoxaemic state that persists longer than in horses that do not develop post operative shock. Horses that developed post operative shock tended to be the individuals that showed more severe colic and signs of shock preoperatively. This also suggests that these horses are more likely to be affected by severe endotoxaemia. Unlike the findings of French *et al.* (2002), there was no direct association between preoperative features and the subsequent development of jugular vein thrombosis in this study. In the study by French *et al.* (2002), multivariable models were used to demonstrate that both heart rate >60 beats/min and elevated PCV at admission (both assumed to be effects of endotoxaemia) were significant risk factors for jugular vein thrombosis. Both studies suggest that factors that reduce the degree of endotoxaemia (e.g. early diagnosis and treatment, with 'antiendotoxin' protocols) should help to reduce the incidence of post operative jugular vein thrombophlebitis. The association between post operative pain and the development of jugular vein thrombophlebitis may reflect the fact that shock was more common in horses with post operative pain. Additionally, horses with post operative pain may be more likely to traumatise and contaminate the site of i.v. catheter placement, thereby increasing the risk of thrombophlebitis.

Wound complications were recorded in 73/252 (29.0%) horses. This involved drainage in 63 horses and wound sepsis in 10 horses. Previously recorded rates of wound complications have varied widely: 7.4% (Freeman *et al.* 2000); 23% (MacDonald *et al.* 1989); 25.4% (Honnas and Cohen 1997); 25.7% (Kobluk *et al.* 1989); and 37% (Phillips and Walmsley 1993). More recently, wound suppuration was recorded in 16% of horses (Proudman *et al.* 2002). Clearly, wound complications are a major post operative problem, and further investigations into preventative procedures are warranted. In the current study, lower rates of wound complications were associated with the intraperitoneal administration of heparin during surgery; this apparent association is difficult to explain, but should be investigated further before it is recommended as a routine therapy. It should be recognised that only univariable analyses were undertaken in this study, and there may be confounding factors that could have affected results such as this. A higher rate of wound complications was recorded in horses that were treated with intraperitoneal antimicrobial drugs during surgery, which probably reflects the fact that they would routinely be administered only in cases where peritoneal contamination was considered likely. Significant peritoneal contamination during surgery was associated with a higher rate of wound complications, as was the development of post operative peritonitis.

Although there was no demonstrable association between surgical technique and the development of wound complications, performing an enterotomy has been associated with an increased risk of incisional infection in one study (Honnas and Cohen 1997); other studies have not supported this observation (Kobluk *et al.* 1989; Phillips and Walmsley 1993). Phillips and Walmsley (1993) recorded a higher rate of wound suppuration in horses that had caecum/large colon obstruction. These authors postulated that the exteriorisation of the large colon for treatment of colonic obstructions might traumatise the abdominal wound and thereby give rise to a higher rate of wound infections. No such association between caecum/large colon obstructions and wound complications was found in the present study. Antimicrobial administration into the wound during closure was associated with a lower rate of incisional complications, and this technique should be evaluated further. In contrast, dissection of the *linea alba* to help placement of the sutures was associated with an increased rate of wound complications, probably as a result of increased deadspace. The application of a stent bandage (sutured over the wound and left in place for 3 days) appeared to increase the rate of wound complications, although probably this is partly a reflection of the use of a stent bandage in cases where wound healing was anticipated to be compromised. In retrospect, removal of the stent bandage after 12 h would have been preferable, since delaying its removal may have increased the risk of wound infection. In contrast, the application of an incise drape over the wound for the recovery period appeared to reduce the rate of wound complications, supporting the findings of Galuppo *et al.* (1999). The observation of a lower short-term survival rate in horses that did not develop wound complications can be explained by the fact that this group includes horses that died in the early post operative period.

This study has identified a number of factors that might predispose horses to post operative complications following colic surgery. Further evaluation of these factors, including controlled prospective studies, are warranted in order to assess procedures that may ultimately reduce the rates of such complications.

Acknowledgements

The authors thank Dr Peter Cripps for advice about statistical analyses, and colleagues at the Bell Equine Veterinary Clinic for assistance with the management of these cases. T.S.M. was in receipt of a Specialist Clinical Award from the Home of Rest for Horses. L.J.S. receives funding from the John Crawford Scholarship, and holds the Gerald Leigh Scholarship in equine evidence-based medicine funded by the Beaufort Cottage Educational Trust.

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