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Complications and survival associated with surgical compared with medical management of horses with duodenitis-proximal jejunitis

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Summary

Reasons for performing study: **Based on clinical observation, it is hypothesised that horses with duodenitis-proximal jejunitis (DPJ) that are treated surgically have a shorter duration, smaller volume, and slower rate of nasogastric reflux (NGR) compared to horses treated medically, are more likely to develop diarrhoea than medically managed cases, and have a higher incisional infection rate than a sample population of horses undergoing abdominal exploration for gastrointestinal disease other than DPJ.**

Objectives: **To compare: 1) duration, volume and rate of NGR and the percentage of horses with diarrhoea between medically and surgically treated DPJ cases; and 2) incisional infection rate in horses with DPJ undergoing abdominal exploration to a sample population of horses undergoing abdominal exploration for gastrointestinal disease other than DPJ.**

Methods: **Medical records of cases with DPJ diagnosed 1995–2006 were reviewed. Information obtained included subject details, presenting clinical findings, treatment category (medical/surgical), complications (diarrhoea, incisional infection), and outcome (survival/nonsurvival). Data were analysed using a Chi-squared test and a mixed model analysis of variance. Level of significance was $P<0.05$.**

Results: **Compared to medical cases, surgical cases had significantly decreased survival, a longer duration and larger total volume of NGR, and were more likely to develop diarrhoea. The incisional infection rate for horses with DPJ undergoing abdominal exploration was 16% compared to 7% for the sample population of horses.**

Conclusions: **Surgical treatment of horses with DPJ did not lead to resolution of NGR faster than medical treatment. Surgical cases were more likely to develop diarrhoea and did not have a significantly higher incisional infection rate than the sample population.**

Potential relevance: **Surgical intervention did not appear to lessen the volume or duration of NGR. It is mainly indicated as a diagnostic aid in cases of DPJ that are difficult to differentiate from small intestinal mechanical obstruction.**

Introduction

Equine duodenitis-proximal jejunitis (DPJ) is a syndrome of small intestinal ileus, characterised by abdominal pain, profuse nasogastric reflux (NGR) and inflammation of the duodenum and proximal jejunum (Johnston and Morris 1987; Schumacher *et al.* 1994; Freeman 2000; Cohen *et al.* 2006). The reported prevalence of DPJ is 3–22% of all colic cases (Freeman 2006). Survival rates range from 25–94% (Cohen *et al.* 1994).

Horses with DPJ often present with signs of abdominal pain, dullness, pyrexia, NGR, mild to marked small intestinal distension, leucocytosis and high peritoneal fluid total protein concentrations (Blackwell and White 1982; White *et al.* 1987; Freeman 2000). It can be a challenge to differentiate between small intestinal obstruction (SIO) requiring surgical treatment and DPJ. Surgical treatment of DPJ is generally recommended when the condition cannot be distinguished from an SIO (Johnston and Morris 1987) or when cases are nonresponsive to medical therapy (Freeman 2000). Seahorn *et al.* (1992) did not find either treatment method to be significantly associated with survival. Several studies advocate the use of surgical intervention with survival rates of 63–96% for surgical cases (Leeth and Robertson 1989; Gillis *et al.* 1994; Edwards 2000). There often comes a point in medically managing a case of DPJ where considerable cost of prolonged medical treatment and an inability to obtain a definitive diagnosis without abdominal exploration can necessitate surgery or euthanasia.

Based on clinical observation, it is hypothesised that horses with DPJ treated surgically compared to medically have a shorter duration of illness, smaller volume and slower rate of NGR, are more likely to develop diarrhoea, and have a high incisional infection rate than a sample population of horses undergoing abdominal exploration for gastrointestinal disease other than DPJ.

The objectives of this study were to compare the duration, volume, and rate of NGR and the percentage of horses with diarrhoea between medically and surgically treated DPJ cases and to compare the incisional infection rate in horses with DPJ undergoing abdominal exploration to a sample population of horses under going abdominal exploration for gastrointestinal disease other than DPJ.

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Materials and methods

Case selection

Medical records of horses admitted to the University of Pennsylvania 1995–2006 were reviewed. Horses diagnosed with DPJ (anterior enteritis; enteritis; proximal enteritis; duodenitis; or haemorrhagic enteritis and jejunitis) based on clinical signs and/or surgical findings were selected initially. Horses were considered to have DPJ if that was the sole diagnosis at surgery or were medically treated cases that produced either NGR for >24 h or NGR at a rate >3 l/h for >8 h. These inclusion criteria were instituted to minimise misclassification of horses with diseases, such as carbohydrate engorgement and transient ileus that also cause NGR. Necropsy findings were also used to include or exclude cases that were managed medically as DPJ and were subjected to euthanasia.

Subject details

Information obtained from the medical record included: age; gender; month and season of admission; previous colic history (yes/no); duration of colic prior to admission; attitude at admission (bright, quiet, dull or agitated); pain level at admission (0 = not painful; 1 = mild: flank staring, pawing, kicking at abdomen; 2 = moderate: lying down and rolling; or 3 = marked: persistently rolling and pain unresponsive to analgesia); admission rectal temperature, heart rate, respiratory rate, oral mucous membrane colour (pale cyanotic, pale pink, normal pink, injected or dark cyanotic), level of borborygmi (hypermotile = 3; normal = 2; diminished = 1; absent = 0), packed cell volume (PCV), total plasma protein (TPP), white blood cell count (WBCC), plasma chloride and creatinine concentrations, and blood lactate concentration; peritoneal fluid colour (red or serosanguinous; yellow-orange; or yellow), total protein (peritoneal TP), and nucleated cell count (peritoneal NCC); and volume and colour (red, brown, green or yellow) of NGR at admission.

Treatment

Treatment was categorised as surgical or medical. The duration of time from onset of signs to surgical intervention was recorded. Treatment with plasma was also recorded (yes/no).

Amount of reflux, complications, and outcome

The total volume of NGR (l), duration of NGR (h) and overall rate of NGR (l/h) were recorded for medical and surgical cases. The volume, duration and rate of NGR was recorded pre- and post operatively for horses treated surgically. The number of horses producing ≤2 l reflux post operatively was recorded. A subgroup of cases was selected for analysis based on a prolonged duration of reflux (>24 h) to compare the rate of reflux with outcome.

Treatment complications were recorded as diarrhoea (yes/no), fever (yes/no), thrombophlebitis (yes/no), pneumonia (yes/no), laminitis (yes/no), and incisional infection for surgical cases only (yes/no). The percentage of horses with an incisional infection was compared to a randomly selected, mature, nongeriatric control sample population also undergoing abdominal exploratory surgery (n = 44). This control sample population was also being used to evaluate survival and complication rates in geriatric horses with colic from 2000–2002 (C. Underwood, unpublished data). The percentage of horses with an incisional infection was based on all horses recovering from surgery and then developing an incisional infection during hospitalisation. The duration of hospitalisation was recorded.

Outcome was short-term survival to hospital discharge or nonsurvival.

Statistical analysis

Categorical data were analysed using a Chi-squared test (PROC FREQ, Statistical Analysis System)[1]. Categorical data included treatment (surgical/medical) and outcome (survival/nonsurvival), which were compared to gender; month and season of admission; previous colic history; admission attitude and pain level; oral mucous membrane colour; peritoneal fluid colour; plasma administration; and complications. The percentage of horses with DPJ treated surgically that developed an incisional infection was compared to the percentage of horses treated surgically for non-DPJ gastrointestinal tract disease. The association between outcome and treatment category was also determined. The level of significance was $P<0.05$. Data are presented as percentages.

Continuous data were analysed using a mixed model analysis of variance (ANOVA, PROC MIXED, Statistical Analysis System). The class variables were treatment (surgical/medical), outcome (survival/nonsurvival), and the interaction between treatment and outcome. The dependent variables were age; duration of colic prior to admission; admission rectal temperature, heart rate, respiratory rate, PCV, TPP, WBCC, and plasma chloride, plasma creatinine and blood lactate concentrations; peritoneal TP and peritoneal NCC; volume of NGR at admission; the duration of time to surgery; total volume, duration and overall rate of NGR as well as the volume, duration and rate of NGR pre- and post operatively; and the duration of hospitalisation.

The volume, duration and rate of NGR post operatively was also compared in surgical cases with that in medically treated cases using the same model. The volume, duration and rate of NGR pre- and post operatively in surgically treated cases was compared using a one-way ANOVA with time (pre- vs. post operatively) being the class variable and volume, duration and rate of NGR being the dependent variables. A one-way ANOVA was also used to determine an association between post operative complications (diarrhoea, fever, incisional infection) which were the class variables and the volume, duration and rate of post operative NGR. The level of significance was $P<0.05$. Data are presented as mean ± s.d. Only significant data are reported.

Pearson's correlation coefficient (PROC CORR, Statistical Analysis System) was calculated for the continuous variables. The level of significance was $P<0.05$ and a mild correlation was defined as being significant and <0.4, moderate 0.4–0.7, and good >0.7.

Results

Case selection

During the study period, 186 cases were selected based on the clinical, surgical, or necropsy diagnosis. Based on the duration or rate of reflux, 66 cases were excluded. Therefore, there were 120 horses meeting the study inclusion criteria.

Subject details and admission information

Clinical signs at admission: The association with treatment category and outcome are shown in Table 1. Surgically compared to medically treated cases had a higher admission pain score and lower admission rectal temperature. Horses subjected to euthanasia had a higher admission heart rate compared to horses that survived. Surgical cases subjected to euthanasia had decreased borborygmi (0.14) at admission compared to those that survived (level 1.04) and compared to medical cases that survived (0.9) or were subjected to euthanasia (1.25; P = 0.01 for the interaction between treatment category and outcome). There was a mild negative correlation between pain level and duration of signs prior to admission (r = -0.38, P = 0.03) and a trend towards a mild positive correlation between duration of signs prior to admission and admission borborygmi (r = 0.35, P = 0.06).

There was a significant association between attitude at admission and treatment category (P = 0.03); 15% (5/33) of horses that were bright, 34% (13/38) of horses that were quiet, 24% (11/46) of horses that were dull and both horses that were agitated (2/2) were treated surgically. There was also a significant association between attitude at admission and outcome (P = 0.03); all (33/33) of the horses that were bright, 82% (31/38) of the horses that were quiet, 85% (39/46) of the horses that were dull and 50% (1/2) of the horses that were agitated survived.

Clinicopathology: Laboratory findings and their association with treatment category and outcome are shown in Table 2. Horses that were subjected to euthanasia had a higher admission PCV, plasma creatinine concentration, peritoneal TP and peritoneal NCC. There was a moderate positive correlation between admission PCV and TPP (r = 0.5, P<0.001), plasma creatinine concentration (r = 0.5, P<0.0001), blood lactate concentration (r = 0.4, P<0.0001), and peritoneal TP (r = 0.5, P<0.0001); and between plasma creatinine concentration and TPP (r = 0.6, P = 0.003) and blood lactate concentration (r = 0.4, P<0.0001). There was a mild negative correlation between plasma chloride concentration and TPP (r = -0.3, P = 0.002) and a moderate negative correlation between plasma chloride and creatinine concentrations (r = -0.6, P<0.0001).

The volume of NGR at admission was mildly correlated with TPP (r = 0.3, P = 0.0001), creatinine concentration (r = 0.3, P = 0.005), total duration of NGR (r = 0.3, P = 0.0004), total volume of NGR (r = 0.3, P = 0.0004) and overall rate of NGR (r = 0.3, P = 0.0004). For surgical cases, the volume of NGR at admission was also positively correlated with preoperative duration (r = 0.4, P = 0.02), volume (r = 0.5, P = 0.004), and rate (r = 0.5, P = 0.007) of NGR as well as the volume of NGR post operatively (r = 0.4, P = 0.03).

Treatment

Of the 120 horses, 88 were managed medically and 32 surgically. The median time from admission to surgery was 14 h (mean 36 h, range 4–121 h). Fifty-eight percent of surgical cases and only 14% of medical cases were treated with plasma (P<0.0001). Of horses that received plasma, 73% (22/30) survived whereas of horses not receiving plasma 92% (80/87) survived (P = 0.009).

Amount of reflux, complications, and outcome

Reflux: Horses that were treated surgically had a greater total volume and a longer total duration of reflux compared to horses that were treated medically (Table 3). Only 28% (9/32) of surgically treated cases produced ≤2 l NGR post operatively. Surgically treated cases that did not survive (n = 8) produced a significantly larger volume of both total and post operative NGR

TABLE 1: Clinical signs at admission for medical vs. surgical treatment group and survival vs. euthanasia outcome (mean ± s.d.)

	Treatment group		Outcome	
Clinical signs	Medical	Surgical	Survived	Euthanasia
Pain score	1.6 ± 0.6‡	2.0 ± 0.8‡	1.7 ± 7	1.8 ± 0.8
Duration of colic prior to admission (h)	15 ± 21	24 ± 55	17 ± 34	19 ± 31
Heart rate beats/min	62 ± 20	70 ± 22	61 ± 19‡	82 ± 22‡
Respiratory rate breaths/min	23 ± 10	24 ± 9	22 ± 9	26 ± 9
Temperature (ºC)	38.1 ± 0.8†	37.8 ± 0.8†	38.1 ± 0.8	38.2 ± 0.9
Nasogastric reflux at admission (l)	10.8 ± 7	10.2 ± 7	10.7 ± 7	11 ± 8
Borborygmi	0.9 ± 0.8	0.8 ± 1.0	1.0 ± 0.9	0.7 ± 0.9

Significant difference between the treatment groups or outcome categories: †P<0.05; ‡P<0.001.

TABLE 2: Clinicopathological findings at admission for medical vs. surgical treatment group and survival vs. euthanasia outcome (mean ± s.d.)

	Treatment group		Outcome	
Laboratory value	Medical	Surgical	Survived	Euthanasia
PCV (%)	46 ± 8	47 ± 11	46 ± 8†	52 ± 12†
TPP (g/l)	74 ± 10	73 ± 12	74 ± 10	76 ± 16
WBCC (10^9/l)	9.3 ± 3.6	9.3 ± 4.1	6.47 ± 5.46	7.06 ± 4.43
Chloride (meq/l)	94 ± 7.7	93 ± 7.7	93 ± 10.8	91 ± 10
Creatinine (mg/l)	26 ± 17	26 ± 14	24 ± 12†	38 ± 29†
Lactate (mmol/l)	2.8 ± 2.7	4.3 ± 3	2.9 ± 2.8	4.3 ± 2.4
Peritoneal TP (g/l)	27 ± 14	35 ± 11	27 ± 13†	43 ± 11†
Peritoneal NCC (10^9/l)	9.8 ± 36.7	8.9 ± 12.7	4.6 ± 5.15†	40.7 ± 85.5†

Significant difference between the treatment groups or outcome categories: †P<0.05; ‡P<0.001; PCV = packed cell volume; TPP = total plasma protein; WBCC = white blood cell count; TP = total protein; NCC = nucleated cell count.

than those that did survive (n = 25, 154 ± 171 l vs. 60 ± 83 l, P = 0.003 and 220 ± 207 l vs. 52 ± 107 l, P = 0.006, respectively). For surgical cases, duration of post operative NGR had a significant association with survival (P = 0.003); surviving cases produced post operative NGR for a shorter period than nonsurviving cases (mean ± s.d. 36 ± 45 h vs. 113 ± 94 h). There was a trend toward an association between rate of NGR preoperatively and outcome for surgical cases (P = 0.08), with surviving horses having a mean preoperative NGR rate of 1.5 ± 1.6 l/h and nonsurviving horses having a preoperative NGR rate of 2.6 ± 0.8 l/h. There was no correlation between duration, volume or rate of NGR preoperatively and duration, volume or rate of NGR post operatively for surgical cases (Fig 1). However, surgically treated cases had a significantly longer duration of NGR post operatively compared to preoperatively (54 vs. 17 h, P = 0.005). There was no significant difference in the volume or rate of NGR preoperatively compared to post operatively in surgical cases.

Comparison of post operative volume and duration of NGR for surgical cases to total volume and duration of NGR for medical cases, yielded a significant interaction between treatment category and outcome (P = 0.008 and P = 0.004, respectively). There was no difference in the volume or duration of NGR between horses treated medically or surgically that survived; however, horses treated surgically that did not survive had a significantly higher volume and duration of NGR compared to surviving or nonsurviving medically treated horses and surviving surgically treated horses.

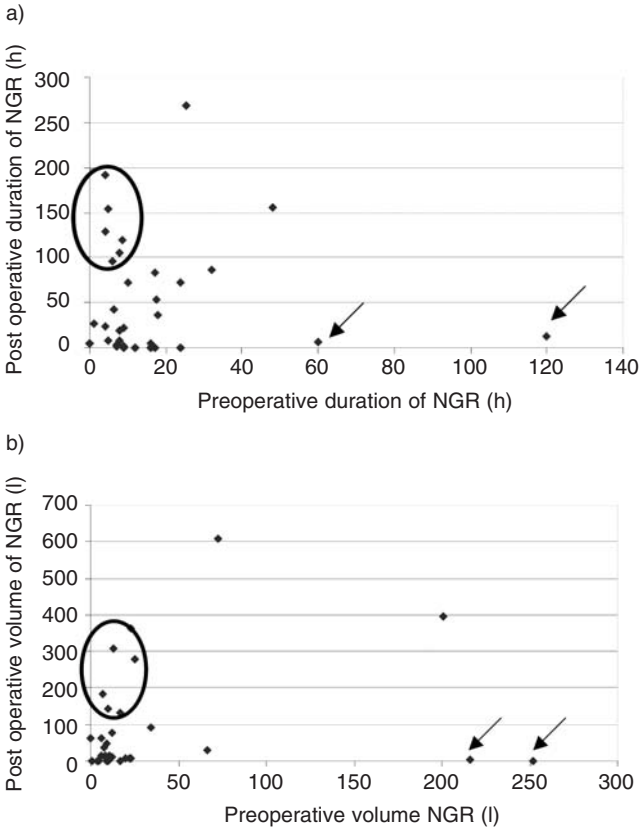

Fig 1: Correlation between duration (a) and volume (b) of reflux pre- and post operatively. While there was no correlation between the duration or volume of reflux pre- or post operatively, it can be seen from the figures that some horses with a long duration and large volume of reflux preoperatively ceased refluxing immediately post operatively (arrows) whereas other horses with a short duration and small volume of reflux preoperatively and a more prolonged course of disease post operatively (circle).

In focusing on associations between post operative reflux in surgical cases and other clinical features, a mild positive correlation between age and duration of NGR was found post operatively (r = 0.36, P = 0.046, Fig 2) and a trend toward a mild positive correlation between age and volume of NGR post operatively (r = 0.29, P = 0.1); and a trend toward a mild negative correlation between admission borborygmi and duration (r = -0.33, P = 0.07) and volume (r = -0.37, P = 0.045) of post operative NGR. There was a trend toward horses with a post operative fever having a larger volume of NGR post operatively (128 vs. 30 l, P = 0.07).

Duration of hospitalisation: There was no significant difference in mean duration of hospitalisation between horses treated medically or surgically (mean ± s.d. 10 ± 4 and 10 ± 6 days, respectively) and horses that survived vs. those subjected to euthanasia (11 ± 38 and 7 ± 7 days, respectively).

Diarrhoea: There was a significant association between treatment category and the development of diarrhoea (P = 0.04); 12.5% (11/88) of cases managed medically developed diarrhoea compared to 28.1% (9/32) of surgical cases. There was no association between development of diarrhoea and outcome.

Fever: Fifty-six percent (67/120) of cases developed a fever; there was no association between fever and treatment category or outcome. Six percent (7/120) of cases developed thrombophlebitis; there was no association between the development of thrombophlebitis and treatment category or outcome. Pneumonia occurred as a complication in 5% (6/120) of cases; 4.5% (4/88) of medical cases and 6.3% (2/32) of surgical cases. Eight percent (9/120) of cases developed laminitis (medical

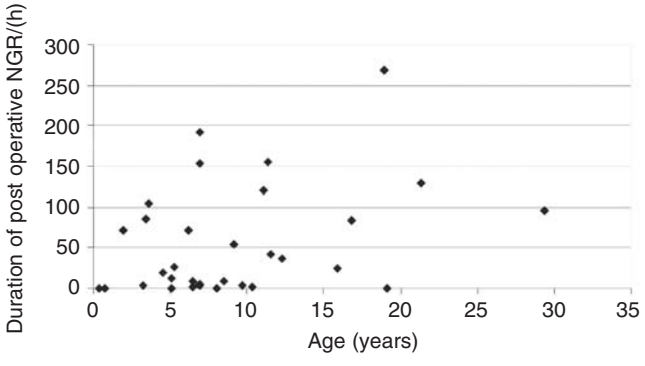

Fig 2: Correlation between age and duration of reflux post operatively.

TABLE 3: Total duration, total volume and overall rate of nasogastric reflux for medical vs. surgical treatment group and survival vs. euthanasia outcome (mean ± s.d.)

Reflux	Treatment group		Outcome	
	Medical	Surgical	Survival	Euthanasia
Total duration (h)	35 ± 32‡	74 ± 71‡	40 ± 39†	82 ± 80†
Total volume (l)	56 ± 57†	118 ± 173†	60 ± 83†	135 ± 171†
Overall rate (l/h)	1.8 ± 1.0	1.3 ± 1.0	1.6 ± 1.0	1.8 ± 0.9

Significant difference between the treatment groups or outcome categories: †P<0.05; ‡P<0.001.

cases 5.7% [5/88] and surgical cases 12.5% [4/32]) but the difference was not significantly different (P = 0.2). There was a trend between development of laminitis and outcome (P = 0.07); only 67% (6/9) of horses that developed laminitis survived compared to 88% (98/111) of horses without laminitis.

Incisional infection: Sixteen percent (5/32) of horses with DPJ undergoing surgery developed and incisional infection. This was not significantly different (P = 0.2) from incisional infection rate in a sample population of horses undergoing abdominal exploration for gastrointestinal disease other than DPJ (7%, 3/44).

The overall survival rate: The overall survival rate for all cases in this study was 87%. There was a significant association between medical or surgical treatment category and outcome (P = 0.02). Medically managed cases were more likely to survive (91%, 80/88) than horses treated surgically (75%, 24/32). Where recorded, reasons for euthanasia included laminitis (3 cases), intestinal appearance at surgery (one case), persistent NGR (7 cases), and pneumonia (one case).

Discussion

The first hypothesis, that horses with duodenitis-proximal jejunitis (DPJ) treated surgically have a shorter duration, smaller volume, and slower rate of nasogastric reflux compared to horses treated medically, was not accepted. Surgically treated horses had a larger total volume and longer duration of NGR compared to medically treated horses. One of the major limitations of this retrospective study was that horses were not assigned randomly to medical or surgical treatment category; hence one obvious explanation for this finding is that horses with a larger volume and/or longer duration of reflux are more likely to undergo an abdominal exploration.

Volume and duration of post operative NGR in surgical cases was compared to that in medically treated cases. With these criteria, horses treated surgically did not have a smaller volume or shorter duration of post operative NGR compared to total NGR of horses treated medically. The perception that surgical intervention results in a rapid cessation of NGR may be based on cases that would have ceased refluxing with medical treatment alone. It has been proposed in previous reports that surgically treated cases are more critically ill compared to medically treated cases, explaining the lower survival and more substantial NGR (Freeman 2000). However, in the present study there was no difference in admission heart rate, PCV, plasma creatinine or blood lactate concentrations, or peritoneal TP or peritoneal NCC between surgically and medically treated cases, suggesting that there was no difference in the extent of critical illness between the medically and surgically treated cases at admission. On the other hand, the significant increase in plasma administration for surgical cases may imply that more surgical cases showed clinical signs of endotoxaemia and were more critically ill. It appeared that surgically treated cases were more likely to be painful or agitated compared to medically treated cases and had lower admission rectal temperatures. The pain level and rectal temperature probably influenced the clinician's decision to manage the case medically or surgically. Unfortunately, because of the retrospective nature of this study, admission clinical and laboratory data could be compared only between the groups because of the challenge of selecting a reasonable time point during medical management in which to compare preoperative clinical and laboratory values in surgical cases.

In the present study, surgical treatment was significantly associated with a less favourable outcome. It could be concluded, based on the lower survival and greater duration and volume of reflux, that surgery is detrimental, but although it can be concluded that surgery did not result in a more rapid cessation of NGR compared to medical management, a prospective randomised clinical trial would be necessary to demonstrate that surgical intervention actually caused the prolonged duration and greater volume of NGR and higher mortality. In order to investigate possible reasons for a longer duration or greater volume of NGR post operatively in surgical cases, the correlation between admission clinical data, post operative complications and duration, volume and rate of post operative NGR was recorded and there was some correlation between age, intestinal borborygmi and fever, and volume or duration of NGR.

In an unrelated study, geriatric horses with salmonellosis were found to have a significantly higher mortality compared to nongeriatric horses (H. Aceto, unpublished data). There was no difference in the percentage of geriatric horses (age >16 years) between medical and surgical treatment groups and no difference in mean age between medical and surgical treatment groups. The association with intestinal borborygmi and fever with duration of post operative NGR was not strong (i.e. trend); however, this may reflect the disease aetiology that leads to the decision for surgery and prolonged post operative NGR. Surgical cases also had a lower admission rectal temperature and higher pain level, which may also reflect the disease aetiology.

Surgical treatment of DPJ is recommended when the condition cannot be distinguished from SIO (Johnston and Morris 1987) or when cases are nonresponsive to medical therapy (Freeman 2000). In the present study, there was no correlation between duration of preoperative NGR and duration or volume of NGR produced post operatively, and no association between duration of clinical signs prior to surgery and outcome. It could therefore be extrapolated that prompt surgical treatment does not affect outcome. However, the implication of delaying surgery in a case with SIO underscores the importance of prompt surgical therapy when the diagnosis is in doubt.

Horses with DPJ treated surgically were more likely to develop diarrhoea compared to medically treated cases. This may be a consequence of the cause (i.e. horses with DPJ associated with a particular cause are more likely to require surgery and develop diarrhoea compared to that associated with other causes) or associated with manipulation of the ingesta from the small intestine into the large intestine, without the performance of an enterotomy. Nineteen percent (6/32) of surgical cases had a pelvic flexure enterotomy performed and only one of these (16%) developed diarrhoea, compared to 28% of all surgical cases. There was no association between the development of diarrhoea and outcome; therefore, although this is a frustrating complication it does not appear to affect prognosis.

The incisional infection rate was not significantly increased when compared to the sample population. However, there was no long-term follow-up beyond discharge and all cases that recovered from surgery were included as the denominator. Only cases that survived could be included, but some horses with DPJ developed an incisional infection prior to euthanasia. The same denominator was used for DJP and the sample population cases. Further, although the difference was not statistically significant, with a

larger number, a difference between groups may have been found, with DPJ cases actually having a higher infection rate.

Of the 120 horses in the study, 9 (7.5%) developed laminitis. This is lower than the 28.4% (33/116) of DPJ cases developing laminitis described by Cohen *et al.* (1994). This may be due to differences in DPJ classification: Cohen *et al.* (1994) excluded all cases producing NGR for <48 h; horses in that study may therefore have been suffering from a more severe form of DPJ than those in the present study and hence the predisposition to laminitis. There was a trend between development of laminitis and outcome. The lack of significance of these data is probably due to an insufficient number of cases developing laminitis.

Diagnosis of DPJ can be confirmed only by finding characteristic lesions during surgery or necropsy (White *et al.* 1987). On a clinical basis, diagnosis of DPJ is based on clinical course, clinicopathological findings, and response to treatment. The lack of a distinct clinical definition of DPJ, or set of inclusion criteria, makes accurate comparison between retrospective studies difficult. Mortality and complication rates reported in these studies are influenced by the inclusion criteria. In this study, inclusion criteria were based initially upon a clinical diagnosis by the primary clinician and then cases with smaller amounts or duration of NGR were excluded. These criteria were used to limit misclassification of horses with similar clinical signs (e.g. uncomplicated ileus) whilst including a group of cases that would be representative of those perceived as having DPJ at this hospital, making the results of the study clinically applicable. The success of our inclusion criteria is illustrated by the clinical findings of this study concurring with those of previous reports (Blackwell and White 1982; Johnston and Morris 1987; Leeth and Robertson 1989; Freeman 2000). These inclusion criteria may, however, still result in inclusion of horses with diseases other than DPJ, and also in exclusion of some milder cases of DPJ.

The clinicopathological changes associated with DPJ are the result of inflammation and endotoxaemia superimposed on a functional (i.e. as opposed to a mechanical) obstruction with sequestration of fluid in the gastrointestinal tract (Johnston and Morris 1987; Schumacher *et al.* 1994; Edwards 2000). In the present study, they included azotaemia, hyperlactaemia, white blood cell counts varying from leucocytosis to leucopenia, haemoconcentration, and both hypochloraemia and hyperchloraemia. Haemoconcentration (high PCV) and azotaemia were significantly associated with nonsurvival. Tachycardia is mediated by the sympathetic nervous system and may accompany endotoxic shock and/or hypovolaemia. The association of nonsurvival with attitude (agitation, dullness), tachycardia, PCV, and creatinine leads to a general clinical picture which can be associated with a less favourable prognosis. Laboratory and clinical findings indicate that nonsurviving horses were more hypovolaemic and endotoxic at admission than survivors.

Horses with increasingly severe DPJ suffer from increased fluid loss through gastric and intestinal secretions due to marked intestinal inflammation. They also develop increased peritoneal TP as blood and/or plasma leaks into the peritoneal cavity due to serositis and small intestinal distension (Johnston and Morris 1987). Increased peritoneal TP has been associated previously with poor prognosis in DPJ cases (Seahorn *et al.* 1994). The peritoneal TP was significantly higher in nonsurvivors compared with survivors in the present study. The significant association between duration of NGR and survival and increased peritoneal TP and survival reflects greater intestinal pathology in persistent cases (Johnston and Morris 1987; Seahorn *et al.* 1992; Edwards 2000).

There was no association between rate of NGR and treatment category or outcome. This indicates the increased volume of NGR in nonsurviving and surgical cases is due to increased duration of NGR. There was a trend toward an association between rate of preoperative NGR and survival in surgical cases. Volume of NGR removed via nasogastric tube in the first 24 h after admission had previously been associated with nonsurvival (Seahorn *et al.* 1992), but this was not calculated in this report. To decrease variability between the 2 studies all horses that refluxed for <24 h were excluded and results recalculated. While there was still no significant association between NGR rate and outcome, there was a strong trend.

In conclusion, surgical cases had a lower survival than medically managed cases. Surgical treatment of horses with DPJ does not lead to resolution of NGR faster than medical treatment. Surgical cases were more likely to develop diarrhoea compared to medically treated horses, but the development of diarrhoea was not associated with a less favourable outcome; and surgically treated cases of DPJ did not have a high incisional infection rate when compared to the sample population.

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Manufacturer's address

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