

# Survival and complication rates in 300 horses undergoing surgical treatment of colic. Part 3: Long-term complications and survival

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## Summary

**Reasons for performing study:** Few studies have evaluated long-term survival and complication rates in horses following surgical treatment of colic, making it difficult to offer realistic advice concerning long-term prognosis.

**Objective:** To review the complications occurring after discharge from hospital and survival to >12 months after surgery of 300 horses undergoing exploratory laparotomy for acute colic. Pre-, intra- and post operative factors that affected long-term complications and long-term survival were assessed.

**Methods:** History, clinical findings, surgical findings and procedures and post operative treatments of 300 consecutive surgical colic cases (1994–2001) were reviewed. Long-term follow-up information was retrieved from case records and telephone enquiries from owners.

**Results:** The long-term (>12 months) survival rate for 204 horses discharged after colic surgery and for which follow-up information was available was 84%. The most common complication after discharge was colic, affecting 35.1% of horses following a single laparotomy. Colic was most common in horses that had had small intestinal obstructions, bowel resection or post operative ileus. Abdominal adhesions were most common in horses that presented with severe colic due to strangulation of small intestine. Ventral hernia formation occurred in 8% of horses, and was most common in horses that had had post operative wound drainage or infection.

**Conclusions:** This study identified various factors that appear to predispose horses to long-term complications after colic surgery.

**Potential relevance:** Further evaluation of strategies that might reduce the incidence of such complications are needed; in particular, the value of intraperitoneal heparin should be evaluated, and procedures designed to reduce the rates of wound drainage and infection assessed.

## Introduction

Mair and Smith (2005a,b) analysed the short-term survival and complication rates of 300 horses undergoing surgical treatment for

acute colic. Short-term survival rates (i.e. survival to discharge from the hospital) of surgical colic cases have also been reported by a number of other equine hospitals. The pattern of post operative survival has recently been documented in detail by Proudman *et al.* (2002a,b), showing a high mortality rate in the first few days post operatively, continuing mortality at a lower rate up to 100–120 days, followed by a low level of mortality. Therefore, short-term survival rates give an incomplete and possibly unrealistic picture of post operative survival, and survival rates in the longer term provide more useful information. Long-term survival rates have been evaluated in only a small number of studies (Phillips and Walmsley 1993; Freeman *et al.* 2000; Van der Linden *et al.* 2003) and it is therefore difficult to offer owners realistic advice concerning long-term prognosis for horses presenting with surgical colic. In this report, the long-term survival and complication rates in the same 300 horses described previously (Mair and Smith 2005a,b) are reviewed.

## Materials and methods

The 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, their treatments and methods of data collection have been reported elsewhere (Mair and Smith 2005a).

For horses discharged alive from the hospital, follow-up information was obtained at 12 months following discharge, and approximately every 6 months thereafter. Follow-up information was obtained by reference to computerised case records and telephone conversations with owners. Data were recorded directly into the statistics database. Recorded follow-up information included details of any colic episodes exhibited by the horse after discharge, and wound complications. Results of *post mortem* examinations were recorded. The rate of confirmed clinically significant adhesions was estimated from the results of *post mortem* examinations and repeat laparotomies. Information on wound complications included the presence or absence of a ventral hernia. Because difficulties were encountered in obtaining information about wound drainage after discharge, this complication was not studied. Other complications recorded included weight loss and laminitis.

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**TABLE 1: Long-term complication rates among 204 horses discharged after colic surgery**

Status at follow-up	n	Mean $\pm$ s.d. time since discharge (months)	Complication		
			Colic	Weight loss	Ventral hernia
Alive	171	28.6 $\pm$ 15.9	43 (25.1%) 95% CI 0.19–0.32	1 (0.5%) 95% CI 0.00–0.03	12 (7.0%) 95% CI 0.04–0.12
Dead	33	21.5 $\pm$ 15.1	13 (39.4%) 95% CI 0.23–0.58	5 (15.2%) 95% CI 0.05–0.32	2 (6.1%) 95% CI 0.01–0.20

Horses were categorised as follows: total number undergoing colic surgery (n = 300); horses discharged home after single or multiple laparotomies (n = 211), for which follow-up information was available in 204 cases; horses discharged home after a single laparotomy (n = 198), of which 183 were not re-admitted for colic during the study period (for which follow-up information was available in 176 cases).

### Statistics

Data were entered into a statistics programme (Minitab for Windows Release 13)<sup>1</sup>. Descriptive statistics (mean  $\pm$  s.d., median, 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 long-term survival and 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

#### Long-term complication rates after a single laparotomy

Of 198 horses that were discharged home after a single laparotomy, 15 (7.5%) were re-admitted to the hospital for surgical treatment of a subsequent episode of colic. Of 183 horses discharged from the hospital following a single laparotomy and not re-admitted for repeat surgery, follow-up information was obtained from 176 (96.2%) (7 were lost to follow-up). Final follow-up was obtained at mean and median times of 26.7  $\pm$  17.1 and 18.0 months post surgery (range 11–69 months), respectively. One hundred and sixty-one/176 horses (91.5%) were alive at the time of this enquiry.

The rate of colic in 191 horses discharged home after a single laparotomy (and for which follow-up information was available) was 67/191 (35.1%). Excluding the 15 horses re-admitted for surgical treatment of a repeat episode of colic, a history of colic after discharge was recorded in 52/176 animals (29.5%). Of the 15 horses that were dead at the time of follow-up, 6 (40.0%) had died of a cause unrelated to colic, and 9 horses (60.0%) had died as a result of colic. Weight loss after discharge was reported in 5 horses (2.8%). A ventral hernia was reported in 12 horses (6.8%). Of the 15 horses that died after discharge, details of *post mortem* examinations were available in 12 cases. Major pathological findings included mesenteric adhesions (n = 5), colon volvulus (n = 2), inflammatory bowel disease (n = 2) and single cases of alimentary lymphoma, right dorsal displacement of the large colon and gastric rupture (without any obvious small intestinal obstruction).

**TABLE 2: Association between the degree of colic, total plasma protein concentration, gut sounds, location of lesion, site and nature of lesion and degree of small intestinal distension with confirmed adhesions (CA) in 190 horses**

	n	No. with CA	95% CI
Severity score of colic			
Mild	47	2 (4.3%)	0.01–0.14
Moderate	98	4 (4.1%)	0.01–0.10
Severe	45	11 (24.4%)	0.13–0.40
Total plasma protein (g/l)			
<60	17	0	0.00–0.16
60–69	67	3 (4.5%)	0.01–0.12
70–79	45	2 (4.4%)	0.01–0.15
80–89	37	9 (24.3%)	0.12–0.41
>90	13	3 (23.1%)	0.05–0.54
Gut sounds			
Normal	32	1 (3.1%)	0.01–0.16
Reduced	92	4 (4.3%)	0.01–0.11
Absent	66	12 (18.2%)	0.10–0.30
Location of lesion			
Small intestine	85	14 (16.5%)	0.09–0.26
Caecum	8	0	0.00–0.31
Large colon	89	2 (2.2%)	0.01–0.08
Small colon	8	1 (12.5%)	0.01–0.53
Site and nature of lesion			
Simple obstruction, small bowel	38	3 (7.9%)	0.02–0.21
Ischaemic obstruction, small bowel	47	11 (23.4%)	0.12–0.38
Simple obstruction, large bowel	88	3 (3.4%)	0.01–0.10
Ischaemic obstruction, large bowel	17	0	0.00–0.16
Small intestinal distension			
None	91	1 (1.1%)	0.00–0.06
Moderate	43	3 (7.0%)	0.01–0.19
Severe	56	13 (23.2%)	0.13–0.36

#### Long-term complication rates in 204 horses discharged after initial treatment of colic

The rates of long-term complications in 204 horses discharged after one or more laparotomies are shown in Table 1.

#### Long-term survival rates

Of the 300 horses that underwent surgery, 293 had follow-up information available; 192/293 were alive at 12 months (long-term survival rate of 65.5%). Of 211 horses that were discharged from the hospital after the initial colic surgery, follow-up information was available for 204 horses. The long-term survival rate in these horses was 83.8%.

#### Association between pre-, intra- and post operative findings and long-term complications

**Adhesions:** Confirmed adhesions causing colic were recorded in 17/190 horses (8.9%) discharged home (excluding peritonitis cases). Adhesions were identified at repeat laparotomy after initial

discharge from the hospital (n = 9) or at *post mortem* examination after discharge from the hospital (n = 8).

Statistically significant associations between the rate of confirmed adhesions and the following variables were identified (Table 2): severity of pain at admission, total plasma protein concentration at admission, abnormal peritoneal fluid (i.e. sanguinous or serosanguinous) at admission, site of intestinal obstruction, and pathological nature of the obstruction. No cases of confirmed adhesion formation occurred in the 15 horses that had omentectomy performed, but there was no statistically significant difference from horses that did not have omentectomy performed.

The rates of confirmed adhesions were significantly higher in horses that had bowel resection (11/52, 21%) compared with those without resections (6/138, 4.3%; OR 5.9; 95% CI 1.84–20.47; P = 0.0003), repeat laparotomy (7/14, 50.0%) compared with single laparotomy (10/176, 5.7%; OR 16.6; 95% CI 3.99–66.54; P < 0.0002), development of post operative ileus (8/21, 38.1%) compared with no ileus (9/169, 5.3%; OR 10.94; 95% CI 3.05–37.65; P < 0.0007) and development of incisional complications (12/67, 17.9%) compared with no complications (5/123, 4.1%; OR 5.15; 95% CI 1.58–19.42; P = 0.001). The rate of confirmed adhesions was significantly lower in horses that received intraperitoneal heparin (3/107, 2.8%) than in those that did not (14/83, 16.9%; OR 0.14; 95% CI 0.03–0.54; P = 0.001).

**Colic:** Episodes of colic were reported in 58 of 204 horses (28.4%) after discharge. This was recorded as sporadic colic in 35 horses, recurrent colic in 17 horses and severe colic (requiring further surgery or euthanasia) in 6 horses.

The frequency of horses showing colic after discharge was significantly higher in horses with abnormal peritoneal fluid (i.e. sanguinous or serosanguinous) (23/54, 42.6%) compared with those with normal fluid (22/102, 21.6%; OR 2.7; 95% CI 1.24–5.87; P = 0.006), small bowel obstruction (34/94, 36.2%) compared with large bowel obstruction (24/115, 20.9%; OR 2.15; 95% CI 1.11–4.18; P = 0.014), resection of intestine (27/56, 48.2%) compared with no resection (31/153, 20.3% OR 3.66; 95% CI 1.80–7.42; P < 0.0006), no intraperitoneal administration of heparin (34/92, 37.0%) compared with administration (24/117, 20.5%; OR 2.27; 95% CI 1.17–4.42; P = 0.008), and development of post operative ileus (10/22, 45.5%) compared with no ileus (48/187, 25.7%; OR 2.41; 95% CI 0.87–6.51; P = 0.05).

Horses that had a history of colic after discharge had a significantly higher death rate at follow-up (15/58, 25.9%) than those with no history of colic (18/151, 11.9%; OR 2.58; 95% CI 1.10–5.92; P = 0.013).

**Ventral hernia formation:** A ventral hernia was reported at follow-up in 14/172 horses (8.1%) for which information was available (i.e. horses discharged following a single laparotomy that were not re-admitted for further surgery and that were alive at the time of follow-up). The rate of hernia formation was significantly higher in horses that developed post operative wound drainage or sepsis (11/57, 19.3%) than in those with no wound drainage (3/115, 2.6% OR 8.93; 95% CI 2.19–51.38; P = 0.0002).

## Discussion

The most frequently recorded long-term post operative complication in this study was colic. At the time of follow-up, 35.1% of horses discharged home following a single laparotomy

had demonstrated at least one further bout of colic. A history of post operative colic was also associated with a significantly higher death rate. Proudman *et al.* (2002a) reported a prevalence of post operative colic of 32% with an incidence of 0.55 episodes/horse year at risk. The majority of first post operative bouts of colic in the latter study occurred within 100 days, but some cases occurred up to one year post operatively. Although many horses described by Proudman *et al.* (2002a) suffered at least one colic episode, only 5% suffered 3 or more episodes. The incidence of colic was 2.8 to 7.6 times higher in horses that had undergone colic surgery than in the general horse population. Multivariable modelling indicated that 2 variables were significantly associated with post operative colic, namely large colon volvulus (>360°) and relaparotomy (French *et al.* 2002). In the present series, no association between post operative colic and large colon volvulus could be identified. In fact, horses with small bowel obstructions had a significantly higher rate of colic than those with large bowel obstructions, and there were apparent associations between rates of colic and both resection of bowel and development of ileus. However, relatively few large colon volvulus cases were treated in this series, and those that showed significant ischaemic change during surgery were invariably subjected to euthanasia rather than treated.

It is probable that a proportion of horses that developed recurrent colic after discharge from the hospital were affected by intra-abdominal adhesions. However, confirmed adhesions were recorded in only 8.9% of 190 horses discharged home. Of horses with small intestinal obstructions, the rate of confirmed adhesions was 16.5%, which is comparable to a rate of confirmed adhesions of 6% in horses following small intestinal surgery in a report by Freeman *et al.* (2000). The precise rate of adhesion formation was impossible to predict, since the exact cause of recurrent or severe colic after discharge from the hospital was usually not determined. In addition, many adhesions are probably clinically 'silent' (Mueller 2002). Adhesions become a clinical problem only when they mature to restrictive fibrous adhesions that compress or anatomically distort the intestine and cause obstruction. Adhesions may also lead to intestinal incarceration, strangulation or volvulus, predisposing the patient to severe or recurrent signs of intestinal obstruction. Published rates of adhesion formation after colic surgery have varied widely, probably as a result of such uncertainties. Previous reports have estimated prevalence of adhesions to be 14% (Phillips and Walmsley 1993), 22% (Baxter *et al.* 1989), 26% (small intestinal obstructions only) (MacDonald *et al.* 1989) and 6% (epiploic foramen entrapments only; Vachon and Fischer 1995). In the present study, confirmed adhesions were most common in horses that presented with severe colic due to strangulating small intestinal obstructions. They were also more common in horses that developed post operative ileus and those that underwent repeat laparotomy.

The primary method of minimising post operative adhesions is the application of meticulous, atraumatic surgical technique (Mueller 2002). Intraperitoneal administration of heparin has been shown to reduce adhesion formation in laboratory animals (Diamond *et al.* 1991; Sahin and Saglam 1994), and the results of our study suggest that its use in horses might reduce the rates of confirmed adhesion formation and post operative colic. However, these findings need to be confirmed with a controlled prospective study. The intraperitoneal heparin treatment was not allocated on a random basis, and it is possible that selection bias may have caused the apparent beneficial effect of this treatment. Systemic administration of heparin was shown in one small experimental

study to reduce rates of abdominal adhesions in ponies (Parker *et al.* 1987); however, a recent experimental study of ischaemia-induced small intestinal adhesions in foals showed that systemic heparin treatment had minimal beneficial effects (Sullins *et al.* 2004). Combinations of intraperitoneal and systemic heparin could be more efficacious than the single intraperitoneal dose used in the present study, and this therapy requires further evaluation in randomised controlled studies.

The use of a bioresorbable hyaluronate-carboxymethylcellulose membrane (Seprafilm II)<sup>2</sup> has been shown to reduce post operative adhesion formation in horses significantly with no adverse effects on intestinal or peritoneal healing (Mueller *et al.* 2000, 2001). Although this technique was used in some horses in this study, the low number precluded any assessment of its efficacy in preventing adhesions. Other reported techniques that have been used to reduce the rate of post operative adhesions include post operative peritoneal lavage (Hague *et al.* 1998) and omentectomy (Kuebelbeck *et al.* 1998). The latter technique was utilised in 15 horses in this study, but the low numbers make it difficult to draw any firm conclusions about efficacy. All of the significant adhesions identified *post mortem* were mesenteric rather than omental, which suggests that omentectomy would be ineffective at preventing this complication. Sodium carboxymethylcellulose solution has also been used in equine abdominal surgery to act as a protective tissue coating, and has been shown to reduce the rate of adhesion formation (Moll *et al.* 1991; Hay *et al.* 2001) with no effect on abdominal wound healing (Mueller *et al.* 1995); this substance was not utilised in the present study.

Ventral hernia formation was recorded in 14/172 horses (8.1%) at the time of follow-up. In a previously reported study, incisional hernias were recorded in 33/210 (16%) of horses that survived a ventral midline laparotomy for at least 4 months (Gibson *et al.* 1989). Wound complications in the immediate post operative period (drainage or infection) and repeat laparotomy were found to be associated with an increased rate of hernia formation, as in previous studies (Gibson *et al.* 1989; Ingle-Fehr *et al.* 1997; French *et al.* 2002). It is probable that wound oedema and inflammation at the laparotomy site result in significant tissue weakening, which in turn predisposes to hernia formation by virtue of sutures tearing through the tissues and/or stretching and thinning of the *linea alba*. In the study by Gibson *et al.* (1989), horses with incisional drainage were 17 times more likely to develop a ventral hernia. Most hernias were not evident at the time of discharge from our hospital, but developed within 2–3 months thereafter. Techniques to reduce the incidence of hernias include the same measures aimed at reducing the rates of wound drainage and infection. The routine use of an abdominal bandage is advocated by some surgeons, but there appear to be no controlled studies that assess the efficacy of this procedure.

Only univariable analyses of the data were undertaken in this study. Such analyses take no account of possible confounding between variables, and this must be taken into consideration in the assessment of the results. However, the study has identified a number of factors that seem to affect the rates of long-term complications following colic surgery, some of which warrant further evaluation. In particular, the value of intraperitoneal heparin in the prevention of intra-abdominal adhesions and post operative colic should be evaluated using randomised controlled studies. Procedures designed to reduce the rates of wound drainage and infection (such as abdominal bandages) could also be assessed as a means of reducing the risk of ventral hernia formation.

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## Manufacturers' addresses

<sup>1</sup>Minitab Inc., State College, Pennsylvania, USA.

<sup>2</sup>Genzyme Corporation, Cambridge, Massachusetts, USA.

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