Analysis of clinical and perioperative findings in 576 horses subjected to surgical treatment of colic

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ABSTRACT: Colic was treated surgically in 576 horses (545 individuals). Twenty-seven horses were subjected to surgery twice and two horses three times during the period of this study. A total of 371 horses (64.4%) were discharged from the hospital, 205 animals (35.6%) died or were euthanised; 16 of them died during anaesthesia, 102 horses were subjected to euthanasia during surgery, 24 patients did not recover from anaesthesia after surgery completion, and 63 horses did not survive the postoperative period. Ileus of the small intestine was diagnosed in 267 cases (46.4%), affection of the large colon in 239 cases (41.5%), lesion of the small colon in 22 cases (3.8%), lesion of the caecum in 19 cases (3.3%), and affection of stomach and rectum in four and one cases, respectively. In 14 animals (2.4%), lesions were located at two different sites of the gastrointestinal tract. In four horses, the cause of colic was located outside the gastrointestinal tract. Three animals were affected by diffuse peritonitis. No gastrointestinal lesion could be identified during surgery in three horses with recurrent colic. The most common causes of small intestine ileus included incarceration in inguinal hernia (50 of 267 horses, 18.7%), hernia of the omental foramen (31 of 267 horses, 11.6%), anterior enteritis (19 of 267 horses, 7.1%), mesenterial volvulus (18 of 267 horses, 6.7%), and ileal impaction (18 of 267 horses, 6.7%). The most common caecal disorder was acute constipation/dysfunction (5 of 19 horses, 26.3%). Frequent causes of the large colon colic were torsion (63 of 239 horses, 26.4%), left dorsal displacement (36 of 239 horses, 15.1%), and right dorsal displacement (23 of 239 horses, 9.6%). The small colon was most often affected by focal obstruction/constipation (9 out of 22 horses, 40.9%). Surgical treatment of colic of the small intestine, caecum, large colon, and small colon was successful in 59.6%, 36.8%, 73.3%, and 63.6% of the cases, respectively.

Keywords: horse; colic; laparotomy; clinical findings; surgical diagnosis; prognosis

Surgical treatment of equine colic is routinely performed in specialised veterinary hospitals. The success of surgical treatment of colic increased substantially due to advances in anaesthesiology, perioperative and postoperative care and surgical technique. Extensive literature on experiences with surgical treatment of equine colic can be found (Pascoe et al., 1983; Siebke et al., 1995; Brodowski et al., 2000; Johnson and Keller, 2005; Mair and Smith, 2005; Plocki, 2005, and others).

Some disorders characterised by colic cannot however be treated yet or can be treated only with difficulties. Surgical treatment of colic is expensive and accompanied by a risk of postoperative complications, even when primary surgery is completed successfully. The probability of the animal's survival plays an important role in the discussion of the veterinarian with the owner of the horse in order to decide whether to treat surgically a patient that does not answer to conservative therapy or not. The outcome of surgery is influenced by a range of factors. The most important are the alteration of the cardiovascular state of a horse prior to surgery and the cause of colic. The aim of this study was to analyse the frequency of lesion types causing colic and to evaluate surgical outcome with regard

Supported by the Ministry of Education, Youth and Sports of the Czech Republic (Grant No. MSM 6215712403).

to results of primary clinical examination during admission to hospital and to surgical diagnosis.

MATERIAL AND METHODS

Of all horses with colic admitted to our hospital from October 1, 1994 to December 31, 2005, we analysed those patients that were subjected to surgery. Patient details, duration of the current episode of colic, results of primary clinical examination and cause of colic as diagnosed during laparotomy were reviewed. Patient details included breed, gender and age of the horse. Animals that were repeatedly admitted to the hospital for surgical treatment of colic were identified and analysed regarding their breed and gender.

All animals subjected to surgery were classified as follows: (i) horses that were treated successfully (i.e. animals that were discharged home), and (ii) horses that died or were euthanised. Long-term survival was not analysed in this study. The group of dead horses included animals that died during anaesthesia, animals that were subjected to euthanasia during surgery, horses that died or were euthanised during the recovery phase, and horses that did not survive the postoperative phase.

For all groups of patients, duration of colic, results of primary clinical examination, lesions causing the colic, and success of treatment were analysed. The cause of death was assessed in horses that did not survive surgery or postoperative period. Complications developing in the postoperative period, indication and results of relaparotomies were not analysed in this study.

At primary examination, severity of behavioural signs of pain, heart rate, colour of conjunctiva and mucous membranes, bowel movements, abdominal distension, state of the body surface and results of rectal examination were recorded. Numerical data were characterised by mean, ± standard deviation, median and range. Discrete data (severity of abdominal pain, bowel movements, abdominal distension, state of body surface, colour of conjunctiva and mucous membranes) were characterised using a scoring system developed at our hospital (Table 1).

Categorical variables were analysed by Chi-squared test, continuous variables by ANOVA test and by post hoc analysis using Fisher's least-significant difference test. Statistical analysis was performed using the programs Microsoft Excel and Statgraphic.

RESULTS

Analysis of patient details

From October 1, 1994 to December 31, 2005, 1 330 horses suffering from colic were subjected to ambulant treatment or admitted to the hospital. In 576 cases (43.3%), surgery was indicated immediately or after unsuccessful conservative treatment. These 576 cases treated surgically were represented by 545 horses, since 27 of them were subjected to surgery twice and two horses three times. 273 (50.1%) of the animals were mares, 149 (27.3%) stallions and 123 (22.6%) geldings. Thirty-six mares were gravid for five months and more. Warmblood horses represented the main group of breeds of 545 animals that underwent laparotomy (278 horses, 51.0%); thoroughbred horses followed with 122 cases (22.4%), White and Black Kladrub Horses with 39 (7.2%), draught horses with 27 (4.9%), American Trotters with 18 (3.3%), ponies with 14 (2.6%), American Quarter Horses with 11 (2.0%), and Huculs with 10 cases (1.8%). Other breeds (4.8%) were represented by less than 10 animals each. The age of the horses ranged from three days to 24 years, mean 6.50 ± 4.25 years, median six years. Seventy-one horses were younger than one year of age (mean 0.6 ± 0.36 years, median 0.6 years).

Results of clinical examination

Table 1 shows the results of primary clinical examination and duration of colic prior to the admission to hospital in horses that were subjected to surgery, that were discharged from hospital, and in the individual groups of patients that did not survive.

Heart rates differed significantly between successfully treated horses and each group of animals that died ($P < 0.05$), between horses that died during anaesthesia and horses that died or were subjected to euthanasia after surgery, and between horses that died during anaesthesia and horses that died or were subjected to euthanasia during the recovery period. The packed cell volume in horses that were treated successfully differed ($P < 0.05$) from that in each group of horses that died. Duration of colic prior to admission differed ($P < 0.05$) between animals that died during anaesthesia and horses that died or were subjected to euthanasia

in the recovery period, between horses that died or were subjected to euthanasia after surgery and horses that did not survive the recovery period, and between animals that did not survive the recovery period and horses that were subjected to euthanasia during surgery.

No significant differences between the individual patient groups could be detected in all other clinical features, i.e. behavioural signs of pain, body surface, colour of mucosal membranes and conjunctiva, abdominal distension, gut sounds, and gastric reflux.

Results of surgical treatment

Of the 576 horses that were subjected to surgery, 371 (64.4%) were discharged home, 205 (35.6%) died or were euthanised. Sixteen (7.8% of dead horses, 2.8% of all horses subjected to surgery) of these 205 animals died after induction or during anaesthesia. In one of them, a near term gravid mare, cardiac arrest occurred after the animal laid down. The foal was alive and could be delivered by Caesarean section.

A total of 102 horses (49.8% of the dead horses, 17.7% of all horses) were subjected to euthanasia during surgery. In 98 of the 102 cases, euthanasia was indicated due to poor prognosis. In two of the four remaining cases, the owner did not agree with extensive resection of the small intestine which would be necessary for the rescue of the horse. In one case, the owner decided for euthanasia due to uncertain viability of the large colon; and in the remaining case, the inflamed large colon ruptured during the manipulation of the intestine.

Twenty four patients (11.7% of the dead horses, 4.2% of all horses) did not recover from anaesthesia after completed surgery. Fifteen of them died, nine animals had to be subjected to euthanasia. Complications included fractures of the femur during the standing up manoeuvre (two horses), fatal myopathy (five horses) and cardiovascular insufficiency (10 horses). In the remaining cases, reasons for euthanasia or causes of death were not recorded.

A total of 63 horses (30.7% of the dead horses, 10.9% of all horses) died or had to be destroyed during the postoperative period.

Surgery was completed in 458 cases. 24 patients (5.2%) did not recover from anaesthesia, 63 horses (13.8%) were subjected to euthanasia during the postoperative period, and 371 horses (81%) were discharged from the hospital.

434 horses recovered from anaesthesia and were subjected to postoperative treatment. In 63 cases (14.5%), complications required euthanasia or caused the death of the animal. 371 horses (85.5%) were treated successfully. In 41 cases, relaparotomy was indicated due to postoperative complications, 21 of the animals survived.

Surgical findings

Table 2 shows the causes of colic as diagnosed in all horses that were subjected to surgery, in horses that recovered and in the individual groups of animals that did not survive.

In 267 cases (46.4%), ileus of the small intestine was a reason for laparotomy, i.e. it represented the most common indication for surgery. In 239 cases (41.5%) were diagnosed disorders of the large colon, in 22 patients (3.8%) disorders of the small colon, in 19 cases (3.3%) disorders of the caecum, in four horses disorders of the stomach, and in one animal, the rectum was affected. In 14 horses (2.4%) severe lesions were located in two different parts of the gastrointestinal tract. The large and the small colon were affected simultaneously in six animals. In four patients, lesions were located in both the small intestine and the large colon. A disorder of the small intestine and caecum was diagnosed in one horse, lesions of the stomach and large colon in one animal, lesions of the small colon and small intestine in one patient, and lesions of the large colon and rectum also in one animal. In four cases, the cause of pain was located outside the gastrointestinal tract. Three animals suffered from diffuse peritonitis without clear reason. No lesions could be identified in three horses that were subjected to surgery for the second time because of persistent colic.

The most common lesions of the small intestine included incarceration in inguinal hernia, which was diagnosed in 50 of 267 horses (18.7%), and incarceration in the omental foramen, which was found in 31 of 267 horses (11.6%). In 19 of 267 cases (7.1%) anterior enteritis and in 18 of 267 cases (6.7%) constipation of the ileum or mesenterial volvulus were identified as the causes of colic.

The most common lesion of the caecum was represented by acute constipation/dysfunction, which affected 5 of 19 patients (26.3%). In 3 of 19 horses

Table 1. Duration of colic and results of clinical examination in horses that were subjected to surgery

	Horses subjected to surgery (n = 576)	Surviving animals (n = 371)	Dead animals (n = 205)	Death during anaesthesia (n = 16)	Euthanasia during surgery (n = 102)	Euthanasia/death during recovery period (n = 24)	Euthanasia/death after surgery (n = 63)
Duration of colic (hours)							
range	0.5–336	1.5–312	0.5–336	4.5–63.5	1–168	2.5–336	0.5–240
mean ± standard deviation	21.51 ± 31.64	20.10 ± 26.31	24.32 ± 39.47	19.83 ± 15.89	19.95 ± 28.37	43.5 ± 67.76	24.17 ± 41.42
median	12	12	12	14	12	21	12
not assessed (number of horses)	34	21	13	1	8	1	3
Behavioural signs of pain (number of horses)							
absent	216	157	59	7	20	9	24
mild	101	74	27	0	15	4	8
moderate	93	65	28	2	17	3	6
severe	113	51	62	3	39	3	17
apathy/indolence	39	14	25	4	7	5	8
not assessed	14	10	4	0	4	0	0
Heart rate (per minute)							
range	30–160	30–135	30–160	48–144	36–140	44–130	30–160
mean ± standard deviation	68.98 ± 22.51	63.87 ± 19.69	78.3 ± 23.59	92.0 ± 24.78	81.01 ± 20.98	77.5 ± 22.76	71.0 ± 25.1
median	66	60	80	92	80	72	67
not assessed (number of horses)	14	8	6	1	4	0	1
Body surface (number of horses)							
dry (cold)	340 (16)	224 (7)	116 (9)	12 (2)	51 (4)	19 (3)	34
dried	12	8	4	0	1	0	3
slightly sweating	66	48	18	1	11	1	5
sweating (cold)	133 (19)	75 (7)	58 (12)	3 (1)	33 (7)	4 (1)	8 (3)
not assessed	25	16	9	0	6	0	3
Colour of mucosal membranes (number of horses)							
pink	307	224	83	5	36	8	34
red	94	64	30	4	15	6	5
cyanotic	118	45	73	7	40	7	19
subicteric	7	5	2	0	0	1	1
anaemic	6	3	3	0	2	1	0
not assessed	44	30	14	0	9	1	4
Colour of conjunctiva (number of horses)							
pink	235	177	58	5	22	7	24
red	218	135	83	7	44	11	21
cyanotic	57	15	42	4	22	3	13
subicteric	12	7	5	0	2	2	1
anaemic	3	2	1	0	1	0	0
not assessed	51	35	16	0	11	1	4

Table 1 to be continued

	Horses subjected to surgery (n = 576)	Surviving animals (n = 371)	Dead animals (n = 205)	Death during anaesthesia (n = 16)	Euthanasia during surgery (n = 102)	Euthanasia/death during recovery period (n = 24)	Euthanasia/death after surgery (n = 63)
Abdominal distension (number of horses)							
absent	350	230	120	6	64	12	38
mild	103	64	39	9	13	3	14
severe	100	63	37	1	21	9	6
not assessed	23	14	9	0	4	0	4
Gut sounds (number of horses)							
normal	63	45	18	1	7	3	7
reduced	212	168	44	3	20	7	14
absent	265	141	124	11	65	11	37
not assessed	36	17	19	1	10	3	5
Gastric reflux (L)							
present (number of horses)	94	57	37	4	16	3	14
range	2–36	2–32	2–36	2–20	2–15	3–36	2–22
mean ± standard deviation	8.79 ± 7.06	8.65 ± 6.81	9 ± 7.44	7.25 ± 7.4	7.20 ± 4.1	14.7 ± 15.11	10.2 ± 6.86
median	7	7.25	6.5	4	6	5	10
absent (number of horses)	184	113	71	6	39	4	22
not assessed (number of horses)	298	201	97	6	47	17	27
Packed cell volume (%)							
assessed (number of horses)	477	320	157	15	73	20	49
range	22–72	22–69	25–72	31–64	28–72	32–66	25–69
mean ± standard deviation	43 ± 9	41 ± 8	47 ± 10	50 ± 9	48 ± 11	45 ± 8	46 ±11
median	41	40	45	50	48	44	44
not assessed (number of horses)	99	51	48	1	29	4	14

reflux present – 2 litres and more, absent – less than 2 litres

(15.8%), torsion of the caecum or caecocaecal invagination was diagnosed.

The large colon was most commonly affected by torsion (63 of 239 animals, 26.4%), left dorsal displacement (36 of 239 horses, 15.1%) and right dorsal displacement (23 of 239 horses, 9.6%).

The most common lesion of the small colon was focal obstruction/constipation, which was found in 9 of 22 animals (40.9%). In other four cases, focal obstruction of the small colon was accompanied by massive constipation of the right dorsal colon.

Primary affection of the stomach was associated with a mortality rate of 100%. Three of four horses were subjected to euthanasia because of a rupture of the obstipated stomach after exploratory laparotomy.

Ileus of the small intestine was treated successfully in 59.6% of the 267 horses affected by this lesion, 40.4% of the animals did not survive. Half the animals were subjected to euthanasia during surgery. The most common lesions were treated comparatively successfully: survival rates were 80%

Table 2. Lesions identified during surgery in horses that were treated successfully and in animals that did not survive

Surgical diagnosis	Horses subjected to surgery	Successfully treated	Euthanasia/ death	Death during anaesthesia	Euthanasia during surgery	Euthanasia/death during recovery	Euthanasia/death after compl. surg.
Stomach	4 100%	0 0%	4 100%	–	3 75%	–	1 25%
constipation and rupture of stomach	3	–	3	–	3	–	–
constipation of stomach	1	–	1	–	–	–	1
Small intestine	267 100%	159 59.6%	108 40.4%	11 4.1%	55 20.6%	6 2.3%	36 13.5%
incarcerated umbilical hernia	2	2	–	–	–	–	–
incarcerated inguinal hernia	50	40	10	–	3	–	7
prolapse of intestine (evisceration) after castration	4	4	–	–	–	–	–
hernia foraminis omentalis	31	16	15	1	9	1	4
hernia mesenterialis	7	4	3	–	1	1	1
hernia pseudoligamentosa	14	6	8	–	4	1	3
hernia ligamentosa	3	1	2	–	2	–	–
hernia diaphragmatica	2	–	2	1	1	–	–
strangulation by pedunculated lipoma	3	–	3	–	2	–	1
strangulation due to Meckel's diverticulum	1	1	–	–	–	–	–
strangulation by mesodiverticular band	2	–	2	–	2	–	–
poststrangulation ileus	16	10	6	–	1	1	4
volvulus mesenterialis	18	7	11	2	8	–	1
volvulus nodosus	14	6	8	1	5	1	1
volvulus mesenterialis et nodosus	1	1	–	–	–	–	–
jejunoileocaecal invagination	2	–	2	–	2	–	–
jejunojejunal invagination	1	1	–	–	–	–	–
ileocaecal invagination	5	3	2	–	–	–	2
duodenal constipation	1	1	–	–	–	–	–
jejunal constipation	6	6	–	–	–	–	–
ileal constipation	18	16	2	–	–	–	2
ileal constipation and ileal diverticulum	2	1	1	1	–	–	–
constipation and hypertrophy of ileum	4	2	2	–	–	–	2
jejunal stenosis	6	5	1	–	–	–	1
obstruction by roundworms	3	1	2	1	–	–	1
compression by abscess	1	–	1	1	–	–	–
intramural haematoma	1	1	–	–	–	–	–
obstruction by mesodiverticular ligament	1	1	–	–	–	–	–
adhesions	12	3	9	–	8	–	1
ischemic necrosis	5	2	3	–	2	–	1
perforation of bowel wall	3	–	3	–	3	–	–
anterior enteritis	19	14	5	2	1	–	2
anterior enteritis and pyloric hypertrophy	1	1	–	–	–	–	–
anterior enteritis and hypertrophy of the ileum	1	1	–	–	–	–	–
jejunitis	7	2	5	1	1	1	2

Table 2 to be continued

Surgical diagnosis	Horses subjected to surgery	Successfully treated	Euthanasia/ death	Death during anaesthesia	Euthanasia during surgery	Euthanasia/death during recovery	Euthanasia/death after compl. surg.
Small intestine and caecum	1 100%	– 0%	1 100%	– 0%	1 100%	– 0%	– 0%
adhesions of small intestine and ischaemic necrosis of the caecum	1	–	1	–	1	–	–
Caecum	19 100%	7 36.8%	12 63.2%	– 0%	8 42.1%	1 5.3%	3 15.8%
torsion	3	1	2	–	2	–	–
caecocaecal invagination	3	1	2	–	1	–	1
caecocolic invagination	2	–	2	–	1	–	1
ischaemic necrosis	1	1	–	–	–	–	–
ischaemic necrosis and synaechia	1	–	1	–	1	–	–
acute constipation/dysfunction	5	4	1	–	–	–	1
chronic constipation	2	–	2	–	1	1	–
constipation and rupture	1	–	1	–	1	–	–
typhlitis and necrosis	1	–	1	–	1	–	–
Large colon	239 100%	175 73.2%	64 26.8%	4 1.7%	26 10.9%	13 5.4%	21 8.8%
torsion	63	35	28	1	16	4	7
torsion and constipation of RDC	3	3	–	–	–	–	–
right dorsal displacement	23	19	4	–	2	2	–
right dorsal displacement with torsion	2	1	1	–	–	–	1
right dorsal displacement and constipation of RDC	4	4	–	–	–	–	–
left dorsal displacement	36	31	5	1	1	–	3
displacement	21	19	2	–	–	–	2
displacement and constipation of RDC	10	10	–	–	–	–	–
displacement and constipation of ventral colon	3	3	–	–	–	–	–
inguinal hernia of large colon	1	–	1	–	–	–	1
mesocolic hernia of large colon	1	1	–	–	–	–	–
adhesions	2	1	1	–	–	–	1
stenosis	1	1	–	–	–	–	–
distension and constipation of ventral colon	6	6	–	–	–	–	–
distension, oedema and peritonitis	1	–	1	–	1	–	–
constipation of ventral colon	12	8	4	1	–	1	2
focal constipation/obstruction of LDC	3	3	–	–	–	–	–
constipation of RDC	16	11	5	–	–	4	1
constipation and distension of ventral colon	3	3	–	–	–	–	–
sand impaction of RDC	3	3	–	–	–	–	–
colitis	9	4	5	1	1	2	1
colitis and typhlitis	1	–	1	–	1	–	–
ischaemic necrosis	8	4	4	–	3	–	1
focal oedema	6	5	1	–	–	–	1
perforation by foreign body	1	–	1	–	1	–	–

Table 2 to be continued

Surgical diagnosis	Horses subjected to surgery	Successfully treated	Euthanasia/ death	Death during anaesthesia	Euthanasia during surgery	Euthanasia/death during recovery	Euthanasia/death after compl. surg.
Large colon and stomach	1 100%	1 100%	– 0%	– 0%	– 0%	– 0%	– 0%
constipation of stomach and large colon	1	1	–	–	–	–	–
Large colon and small intestine	4 100%	3 75%	1 25%	– 0%	– 0%	– 0%	1 25%
ischaemic necrosis of small intestine and colitis	1	–	1	–	–	–	1
anterior enteritis and torsion of large colon	1	1	–	–	–	–	–
mesenterial volvulus and displacement of large colon	2	2	–	–	–	–	–
Small colon	22 100%	14 63.6%	8 36.4%	– 0%	5 22.7%	3 13.7%	– 0%
adhesions	3	1	2	–	2		–
perforation	2	–	2	–	2		–
ischaemic necrosis	2	–	2	–	1	1	–
focal obstruction/constipation	9	7	2	–	–	2	–
diffuse constipation	3	3	–	–	–	–	–
hernia ventralis acreta of small colon	1	1	–	–	–	–	–
hernia mesocolica of small colon	1	1	–	–	–	–	–
stenosis	1	1	–	–	–	–	–
Small colon and large colon	6 100%	6 100%	– 0%	– 0%	– 0%	– 0%	– 0%
constipation of small colon and colitis	1	1	–	–	–	–	–
focal/diffuse constipation and constipation of RDC	4	4	–	–	–	–	–
obstruction of small colon and left dorsal displacement of large colon	1	1	–	–	–	–	–
Small colon and small intestine	1 100%	– 0%	1 100%	– 0%	– 0%	– 0%	1 0%
constipation of small colon and jejunitis	1	–	1	–	–	–	1
Rectum	1 100%	– 0%	1 100%	– 0%	1 100%	– 0%	– 0%
perforation	1	–	1	–	1	–	–
Rectum and large colon	1 100%	– 0%	1 100%	– 0%	1 100%	– 0%	– 0%
displacement of large colon and rectal perforation	1	–	1	–	1	–	–
Peritonitis	3 100%	1 33.5%	2 66.5%	1 33.25%	1 33.25%	– 0%	– 0%
Uterus	3 100%	2 66.5%	1 33.5%	– 0%	– 0%	1 33.5%	– 0%
torsion	3	2	1	–	–	1	–
Kidney	1 100%	– 0%	1 100%	– 0%	1 100%	– 0%	– 0%
neoplasm of the kidney	1	–	1	–	1	–	–
No lesion identified	3 100%	3 100%	– 0%	– 0%	– 0%	– 0%	– 0%
Sum	576	371	205	16	102	24	63

RDC – right dorsal colon, LDC – left dorsal colon

of the animals affected by inguinal hernia (recovery in 40 of 50 horses), 51.6% of the animals with incarceration of the intestine in the omental foramen (recovery in 16 of 31 horses), 38.9% of the animals affected by mesenterial volvulus (recovery in 7 of 18 horses), 88.9% of the animals with constipation of the ileum (recovery in 16 of 18 horses), and 73.7% of the animals affected by anterior enteritis (recovery in 14 of 19 horses). The most frequent colics with inoperable surgical findings represented incarceration of the intestine in the omental foramen (9 of 15 dead horses, 60%), mesenterial volvulus (8 of 11 dead horses, 72.7%) or volvulus nodosus (5 of 8 dead horses, 62.5%), and ileus of the small intestine due to adhesions (8 of 9 dead horses 88.9%).

Of the 19 horses with affection of the caecum, 36.8% were discharged home, 63.2% of them did not survive. Acute constipation/dysfunction was treated successfully in four of five horses (80%). Caecocolic invagination, chronic constipation, rupture and typhlitis accompanied by necrosis were associated with a mortality rate of 100%.

Disorders of the large colon (239 patients) were treated successfully in 73.2% of the cases, 26.8% of the animals had to be destroyed or died. In 26 of the 64 animals that did not survive (40.6%), euthanasia was performed during surgery. The most common lesions of the large colon were treated successfully: survival rates were 55.6% of the animals with torsion of the large colon (recovery in 35 of 63 horses), 86.1% of the animals with left dorsal colon displacement (recovery in 31 of 36 horses), and 82.6% of the animals with right dorsal displacement (recovery in 19 of 23 horses). Torsion of the large colon was inoperable in most animals or required euthanasia during surgery (16 of 28 dead horses, 57.1%).

Of the 22 patients with lesions of the small colon, 63.6% were discharged home after successful treatment, 36.4% of the animals did not survive. Success rates for the treatment of common disorders were 77.8% of the animals with focal obstruction/constipation (recovery in seven of nine horses), 100% of the animals with diffuse constipation (three horses subjected to surgery), and 33.3% of the animals with adhesions of the small colon (recovery in one of three horses).

The most common surgical finding in horses with lesions in two parts of the gastrointestinal tract was simultaneous constipation of the small colon and right dorsal large colon. All four patients affected by this disorder were treated successfully.

DISCUSSION

The success of colic surgery in horses is influenced by factors such as alteration of the general health state, cause and duration of colic as well as by experiences of the surgeon with surgical technique, anaesthesia of patients with the altered cardiovascular state, and with treatment of postoperative complications (Pascoe et al., 1983; Siebke et al., 1995; Brodowski et al., 2000; Freeman et al., 2000; Johnson and Keller, 2005; Mair and Smith, 2005; Plocki, 2005, and others).

Our study analysed a group of 576 horses that were subjected to colic surgery. The long period of study (more than 11 years) allowed the collection of a large number of cases. Therefore, a nearly complete range of lesions requiring surgical treatment and a comparatively correct estimation of the frequency and prognosis of particular disorders can be given in this paper. However, it has to be taken into account that increasing experiences of the surgeons during the study period could cause that fewer cases were classified as inoperable and could improve the success of treatment in the last years. It is known that the competence of the primary surgeon influences the outcome of surgery significantly (Freeman et al., 2000; Plocki, 2005). Studies as ours, which analyse patients treated by the same person (all animals treated by Z.Z. or J.M.; see also Mair and Smith, 2005; Plocki, 2005), exclude the influence of the primary surgeon on the outcome and complications of surgery.

It is difficult to compare success rates of colic surgery because of variations in the categorisation of cases. The number of healed patients can be related to the number of all horses subjected to surgery, to the number of horses with completed surgery or to the number of horses that recovered from anaesthesia (Brodowski et al., 2000; Mair and Smith, 2005). Our study included all horses that were subjected to general anaesthesia; animals that were discharged home were classified as healed. Our success rate is therefore lowered by horses that died during the initiation of anaesthesia or before laparotomy because of poor the cardiovascular state. Of the 576 horses included in our study, 371 were discharged from hospital, i.e. our success rate was 64.4%, similar to that of other authors (50% Pascoe et al., 1983; 50.6% Hunt et al., 1986; 64% Siebke et al., 1995; 72.9% Brodowski et al., 2000). In the patient group analysed by Plocki (2005), 68.2% of all horses subjected to surgery survived. Mair

and Smith (2005) reached a short-term survival rate of 70.3%, Johnson and Keller (2005) of 49%. Success rates seem to be higher in recent studies, perhaps because in the development phase of colic surgery more horses with poor prognosis were subjected to surgery, which led to higher mortality (Pascoe et al., 1983).

Different success rates have been reported for the small and large colon surgery. Generally, outcomes tend to be better in the large colon surgery. Hunt et al. (1986) reported success rates of 52.4% and 47.4% for treatments of the large and small intestine, respectively, Brodowski et al. (2000) reported those of 74% and 71.1%. Siebke et al. (1995) reached survival rates of 72% and 60% for the large colon and small intestine surgery, respectively, Plocki (2005) those of 75.3% and 65.8%, Johnson and Keller (2005) of 54% and 51%. Mair and Smith (2005) discharged from hospital 89.9%, 100% and 75.2% of horses after surgical treatments of the large colon, small colon and small intestine, respectively. Our results are similar to those described above. Lesions of the large colon were treated successfully in 73.2% of the 239 patients, lesions of the small colon in 63.6% of the 22 patients, and simultaneous affection of the large and small colon in all cases. On the other hand, of the 267 horses with lesions of the small intestine, only 59.6% survived. Almost all authors reported significantly lower success rates of the caecum surgery (20% Johnson and Keller, 2005; 56% Siebke et al., 1995; 63.6% Plocki, 2005; 66.7% Mair and Smith, 2005). In our study, 36.8% of the horses with lesions of the caecum survived.

Lesions of other organs than the gastrointestinal tract or lesions that cannot be located to a specific part of the gastrointestinal tract can also cause abdominal pain. Success rates of surgical treatment of such disorders ranged between 18% (Siebke et al., 1995), 28.3% (Plocki, 2005) and 68.4% (Hunt et al., 1986). Primary affection of the stomach, which is often classified as one of these disorders, was associated with a mortality rate of 100% in our group of patients. However, we reached success rates of 66.5% in peritonitis cases and of 50%, when the kidney or uterus lesions were treated surgically.

The frequency of single disorders, i.e. the percentage of affection of the small and large intestine and other organs, influences overall success rates of individual studies. In most of them lesions of the large intestine prevail, which are assumed to have better prognosis than affections of the small intestine. Brodowski et al. (2000) diagnosed lesions of the large and small intestine in 52.9% and 43.3%, respectively. The most frequent reasons for surgery in the study of Plocki (2005) were lesions of the colon (58% of all cases), in comparison with small intestinal ileus (29%) and lesions of the caecum (5%). Johnson and Keller (2005) found lesions of the small intestine in 42% of all cases, and lesions of the colon, stomach and caecum in 41%, 8% and 2% of the cases, respectively. In the group of horses analysed by Siebke et al. (1995), as much as 67% of the animals were affected by lesions of the large intestine and only 25% by small intestinal ileus. In contrast, ileus of the small intestine represented the most frequent reason for surgery in our study. It was diagnosed in 267 animals (46.4%). In other six horses, the lesion of the small intestine was associated with an affection of the large intestine. A higher frequency of small intestinal lesions was also shown by Hunt et al. (1986) (60.2% and 32.4% of lesions of the small and large intestine, respectively) and by Mair and Smith (2005) (49% and 42% of lesions of the small intestine and large colon, respectively).

The number of different lesions causing colic, which could be identified in our study, was substantially larger in comparison with the majority of other studies (Siebke et al., 1995; Brodowski et al., 2000; Mair and Smith 2005, and others). Even rare lesions occurred in our large group of patients, e.g. obstruction of the small intestine by an intramural haematoma, diverticle of the ileum etc. Moreover, we tried to define surgical diagnoses as exactly as possible. Whereas some authors analyse only the main diagnosis of individual cases (Plocki, 2005), many of our patients were affected by two different lesions of the same part of the gastrointestinal tract, which were classified individually, e.g. combined displacement and constipation of the large colon. It is known that the constipation of the right dorsal colon can cause the colon displacement (Hacket, 1983; Specht and Colahan, 1988; Ragle et al., 1989; Huskamp et al., 1999). Constipation of the right dorsal colon accompanied by right dorsal displacement, torsion or other displacement of the colon could be found in 17 of our patients, an evidence that supports this hypothesis. Constipation or invagination of single parts of the small intestine and further lesions were also analysed individually, since their frequency differed substantially. In 14 animals, lesions of comparable severity could be detected simultaneously in two parts of the gastrointestinal tract. These patients were classified as an extra group.

Incarceration in inguinal hernia represented the most common lesion causing ileus of the small intestine (18.7% of horses with lesions of the small intestine). Although this disorder occurs quite frequently, it ranked the third or the fourth in most studies (Siebke et al., 1995; Brodowski et al., 2000; Plocki, 2005). Plocki (2005) and Brodowski et al. (2000) identified inguinal or scrotal hernia in 11.7% and 16.4% of their patients with small intestinal ileus, respectively. In contrast, Mair and Smith (2005) found this lesion only occasionally. The high frequency of inguinal hernia in our patients is probably caused by a predisposition of Black Kladrub Horses to this disorder. Our study group included 39 Black and White Kladrub Horses (7.2%). In Black Kladrub stallions, colic caused by inguinal hernia represented the almost only reason for surgery. Although the number of Kladrub Horses in the Czech Republic is small, Black Kladrubs represent the majority of patients with inguinal hernia.

Hernia foraminis omentalis (11.6%), anterior enteritis (7.1%), mesenterial volvulus (6.7%), constipation of the ileum (6.7%) represented further frequent disorders causing ileus of the small intestine. With the exception of anterior enteritis, they have to be treated surgically (Siebke et al., 1995; Freeman, 1999; Huskamp et al., 1999; Brodowski et al., 2000; Mair and Smith, 2005; Plocki, 2005). Hernia foraminis omentalis represented 24% and 17.3%, mesenterial volvulus 18.3% and 32.3% of small intestinal lesions in the groups analysed by Brodowski et al. (2000) and Plocki (2005), respectively. Constipation of the ileum caused colic in 15.4% (Brodowski et al., 2000) and 17.1% of the cases (Plocki, 2005). Anterior enteritis was treated surgically only in one horse of the group analysed by Siebke et al. (1995), cases described by other authors are also rare. The larger number of animals with this lesion in our group can be explained by the fact that anterior enteritis can be treated conservatively (Huskamp et al., 1999) as well as surgically (Edwards, 2000); so other authors might have preferred conservative treatment and therefore these animals are not included in analyses of colic surgery.

In our study, surgical treatment of the caecum was indicated mostly due to acute constipation/dysfunction (five horses, 26.3%). In other five cases, caecocaecal or caecocolic intussusception was identified, two horses were affected by the torsion of the caecum. Acute constipation/dysfunction represented the most frequent lesion of the caecum also in other studies (Mair and Smith, 2005; Plocki, 2005). Plocki (2005) found acute caecal constipation in 21.2%, torsion in 19.7%, and invagination and chronic constipation in 13.6% of the cases. Mair and Smith (2005) classified caecocaecal and caecocolic intussusception as the second most frequent disorder of the caecum, comparably to our study.

Main indications for the large colon surgery in our patients were torsion (63 horses, 26.4%), left dorsal displacement (36 horses, 15.1%) and right dorsal displacement (23 horses, 9.6%). In other three animals, the large colon torsion was accompanied by massive constipation of the right dorsal colon. Similarly, cases of right dorsal displacement accompanied by massive constipation of the right dorsal colon (four horses) or torsion of the large colon (two horses) were classified as individual lesions. Retroflexion on pelvic flexure and different non-strangulating displacements represented the lesion causing colic in 21 patients. In other 10 horses, this type of displacement was accompanied by massive constipation of the right dorsal colon. Surgical treatment was, however, indicated also in 16 horses affected only by constipation of the right dorsal colon, in three horses with constipation of the right dorsal colon accompanied by the large colon distension, and in three animals suffering from sand impaction of the right dorsal colon. It seems that constipation of the right dorsal colon requires surgical treatment quite frequently and that it is often accompanied by displacement of the large colon. Plocki (2005) diagnosed in his patients with colonic lesions partial torsion in 40.7% of the cases, and left dorsal displacement in 23.6% of the cases. Complete torsion of the large colon was found in 15.9% of the cases. Brodowski et al. (2000) identified torsion (66.1%) and constipation of the large colon (10.1%) as the most frequent large intestinal lesions. Torsion of the large colon and right dorsal displacement prevailed in the group of horses treated by Mair and Smith (2005). Siebke et al. (1995) found preferentially partial torsion and left dorsal displacement.

In our patients, focal obstruction/constipation were typical disorders of the small colon requiring surgical treatment. Interestingly, neither Siebke et al. (1995) nor Plocki (2005) found lesions of the small colon in their patients that underwent colic surgery; Brodowski et al. (2000) diagnosed only meconium retention and strangulation of the large intestine (without further explanation) by pedunculated lipoma. Lesions of the small colon were,

however, found in 4.2% of the patients subjected to colic surgery by Edwards (1992). Surgical treatment of the small colon disorders was analysed by Ruggles and Ross (1991) and Dart et al. (1992).

As found in other studies, some of our patients were affected by stomach lesions, peritonitis, torsion of the uterus and kidney disorders. In the group of Plocki (2005), in 8% of the animals the lesions could not be located to a specific part of the intestine. The most frequent disorders were massive peritonitis (16.1%), meteorism or thromboembolic ischaemia (13.3%), and spontaneous adhesions of unknown origin (11.3%). Brodowski et al. (2000) identified torsion of the uterus in 3.8% of their colic patients.

Main causes of the death of colic patients during anaesthesia and surgery are massive alteration of the cardiovascular state and identification of lesions that are classified as inoperable. Mortality differs substantially in different studies. In our group, 16 horses (2.8% of all horses subjected to surgery, 7.8% of dead horses) died during anaesthesia. Twenty-four animals (4.2% of all horses subjected to surgery, 11.7% of dead horses) did not recover after completed surgery. In the group of Mair and Smith (2005), 1.3% of the animals died during anaesthesia, in the group of Hunt et al. (1986) 9.4% of the dead horses. Long bone fractures, myopathy and cardiovascular failure represent the main causes of death immediately after completed surgery, as described also by Pascoe et al. (1983).

A total of 102 horses (17.7% of all horses subjected to surgery, 49.8% of dead horses) of our study group were subjected to euthanasia during surgery, similarly like in Pascoe et al. (1983) (17.3% of all horses subjected to surgery), Siebke et al. (1995) (15%) and Mair and Smith (2005) (13%). 25% of dead horses of the group of Hunt et al. (1986) and 50% of that of Plocki (2005) were euthanised during surgery. Large numbers of euthanasia in our group can be explained by the fact that the owners wished surgery even if the cardiovascular state of the horse was very poor. Furthermore, sufficient experience of surgeons to exclude patients with poor prognosis from surgery was missing in the first years. Inoperable lesions such as irreversible changes of the whole large colon or caecum, irreversible changes of more than 70% of the small intestine or contamination of the abdominal cavity with chyme were the most frequent reasons for euthanasia. In three animals only, the owner opted for euthanasia because of uncertain prognosis. In one animal, a rupture of the colon due to manipulation during surgery was the indication for euthanasia. Similar problems were also reported by other authors (Siebke et al., 1995; Mair and Smith, 2005; Plocki, 2005).

Success rates in the treatment of different lesions differ substantially. Inguinal hernia was treated successfully in 80%, intestinal prolapse after castration in 100%, incarceration in the omental foramen in 51.6%, mesenterial volvulus in 38.9%, and constipation of the ileum in 88.9% of the cases. Of the 11 horses that died due to mesenterial volvulus, 10 did not survive surgery. High perioperative mortality in horses affected by this lesion is probably caused by quick progradation, severe alteration of the cardiovascular state and its quick deterioration, and involvement of large parts of the small intestine (Freeman, 1999). Success rate of Plocki (2005) for the treatment of mesenterial volvulus was also low, 59.1%.

Similarly, incarceration in the omental foramen was accompanied by high perioperative mortality. This lesion is sometimes characterised by the incarceration of large parts of the small intestine and regarded as inoperable in this case. In other cases, when only a small part of the small intestine is displaced through the omental foramen, prognosis is much better.

Substantially higher success rates for surgical treatment of inguinal hernia and prolapse of the intestine after castration are probably a result of early surgery. In this case, the cardiovascular state of the animals is better, only a small part of the intestine is affected. Our success rates for the treatment of inguinal hernia are higher than those of Schneider et al. (1982) or Rijkenhuizen and Van der Velden (1994).

Constipation of the ileum is regarded as a lesion with good prognosis, as confirmed by a success rate of 82.1% (Plocki, 2005). In contrast, mortality of our patients affected by hernia pseudoligamentosa or strangulation by pedunculated lipoma was high due to the same reasons as described for mesenterial volvulus. Similar results were reported by Mair and Smith (2005) and Plocki (2005).

Acute constipation/dysfunction was treated successfully in 80% of our patients, comparably to the group of Mair and Smith (2005) with 85.7% healed animals. Plocki (2005), however, discharged from hospital only 57.1% of the horses affected by this lesion. Uncertain or poor prognosis of patients with caecocaecal or caecocolic invagination, chronic

constipation, rupture of intestinal wall, and typhlitis accompanied by necrosis as found in our study was also reported by other authors (Mair and Smith, 2005; Plocki, 2005).

Success rates of the treatment of large colonic lesions were 55.6%, 86.1% and 82.2% for torsion, left dorsal displacement and right dorsal displacement, respectively. Euthanasia during surgery because of inoperable torsion of the large colon was performed in 57.1% of the dead horses, similarly like in the group of Mair and Smith (2005). High numbers of horses subjected to euthanasia during surgery can be explained by rapidly progressing irreversible changes of the intestinal wall during 360° torsion of the large colon at the caecocolic fold. Plocki (2005) reached success rates of 76.0% and 51.6% in horses with partial and complete torsion, respectively. Mair and Smith (2005) discharged from hospital 64.7% of the patients affected by colonic torsion. In contrast, the right and left dorsal displacement are lesions with good prognosis (Siebke et al., 1995; Mair and Smith, 2005; Plocki, 2005), as confirmed by our results.

Lesions of the small colon, such as focal obstruction/constipation, diffuse impaction and adhesions were treated with success rates of 77.8%, 100%, and 33.3%, respectively. The treatment of four patients which suffered simultaneously from the constipation of small colon and right dorsal colon was successful in all cases. These high success rates are similar to those of Mair and Smith (2005), and even better than those of Ruggles and Ross (1991).

An alteration of the cardiovascular state limits the success of treatment of horses suffering from colic. Patient details assessed during primary clinical examination were used as indicators of prognosis. Since this is a retrospective study, not all data were available for all patients. In the first years of the study period, laboratory equipment was limited. Haematological and biochemical analysis and assessment of acid-base equilibrium were not possible. Significant differences between animal groups in this study could be shown only for heart rate, packed cell volume and duration of colic prior to admission. Heart rate at admission and packed cell volume differed significantly between horses that were treated successfully and dead horses. The highest heart rate was measured in horses that died during anaesthesia or that were subjected to euthanasia during surgery. In most cases, this group of animals included horses with inoperable findings. It is therefore possible to use heart rate to exclude animals with poor prognosis from surgery. Elevated heart rate represents an indication for euthanasia. High heart rate and high packed cell volume at admission also alert to possible complications during the postoperative period. These data are regarded as important prognostic tools also by other authors (Pascoe et al., 1983; Siebke et al., 1995; Mair and Smith, 2005; Plocki, 2005). The duration of colic prior to surgery cannot easily be used for estimation of prognosis. Although significant differences between single groups of animals could be found in our study, the influence of colic duration on a clinical outcome differs in relation with the nature of the lesion. Prognosis is better for long-lasting non-strangulating obstruction than for rapidly developing intestinal strangulation (Mair and Smith, 2005).

REFERENCES

Brodowski G., Fischer J., Hell H. (2000): Uberlebensrate und Komplikationen chirurgisch behandelter Pferde mit Kolik. Praktischer Tierarzt, 81, 486–493.

Dart A.J., Snyder J.R., Pascoe J.R., Farver T.B, Galuppo L.D. (1992): Abnormal conditions of the equine descending (small) colon: 102 cases (1979–1989). Journal of the American Veterinary Medical Association, 200, 971–978.

Edwards G.B. (1992): A review of 38 cases of small colon obstruction in the horse. Equine Veterinary Journal, Suppl. 13, 42–50.

Edwards G.B. (2000): Duodenitis-proximal jejunitis (anterior enteritis) as a surgical problem. Equine Veterinary Education, 12, 318–321.

Freeman D.E. (1999): Small intestine. In: Auer J.A., Stick J.A. (1999): Equine Surgery. 2nd ed. Saunders, Philadelphia. 232–257.

Freeman D.E., Hammock P., Baker G.J., Goetz T., Foreman J.H., Schaeffer D.J., Richter R.-A., Inoue O., Magid J.H. (2000): Short- and long-term survival and prevalence of postoperative ileus after small intestinal surgery in the horse. Equine Veterinary Journal, Suppl. 32, 42–51.

Hackett R.P. (1983): Nonstrangulated colonic displacement in horses. Journal of the American Veterinary Medical Association, 182, 235–240.

Hunt J.M., Edwards G.B., Clarke K. W. (1986): Incidence, diagnosis and treatment of postoperative complications in colic cases. Equine Veterinary Journal, 18, 264–270.

Huskamp B., Kopf N., Scheidemann W. (1999): Magen-Darm-trakt. In: Dietz O., Huskamp B. (eds.): Hand-

buch Pferde Praxis. Ferdinand Enke Verlag, Stuttgart. 411–502.

Johnson A., Keller H. (2005): Ergebnisse von 1431 stationar behandelten Kolikpatienten, unter besonderer Berucksichtigung der 285 chirurgisch versorgten Pferde, in den Jahren 1990 bis 1997 in der Klinik fur Pferde, Allgemeine Chirurgie und Radiologie der Freien Universitat Berlin. Pferdeheilkunde, 21, 427–438.

Mair T.S., Smith L.J. (2005): Survival and complication rates in 300 horses undergoing surgical treatment of colic. Part 1: Short-term survival following a single laparotomy. Equine Veterinary Journal, 37, 296–302.

Pascoe P.J., McDonell W.N., Trim C.M., van Gorder J. (1983): Mortality rates and associated factors in equine colic operations – a retrospective study of 341 operations. The Canadian Veterinary Journal, 24, 76–85.

Plocki K.A. (2005): Chancen und Risiken von Kolikoperationen. Praktischer Tierarzt, 86, 898–905.

Ragle C.A., Meagher D.M., Lacroix C.A., Honnas C.M. (1989): Surgical treatment of sand colic. Results in 40 horses. Veterinary Surgery, 18, 48–51.

Rijkenhuizen A.B.M., van der Velden M.A. (1994): Irreponible Hernia inguinalis beim Pferd. Wiener Tierarztliche Monatsschrift, 81, 295–301.

Ruggles A.J., Ross M.W. (1991): Medical and surgical management of small-colon impaction in horses: 28 cases (1984–1989). Journal of the American Veterinary Medical Association, 1762–1766.

Schneider K., Milne D.W., Kohn C.W. (1982): Acquired inguinal hernia in the horse: A review of 27 cases. Journal of the American Veterinary Medical Association, 180, 317–320.

Siebke A.U., Keller H., Lauk H.D., von Plocki K.A. (1995): Statistische Erhebung über Kurz- und Langzeitergebnisse von 718 operativ behandelten Kolikpatienten. Pferdeheilkunde, 11, 299–312.

Specht T.E., Colahan P.T. (1988): Surgical treatment of sand colic in equids: 48 cases (1978–1985). Journal of the American Veterinary Medical Association, 193, 1560–1564.

Received: 2007–04–03
Accepted after corrections: 2007–10–10

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