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CLINICAL RESEARCH

Clinical findings, surgical techniques, prognostic factors for short-term survival and long-term outcome in horses with acquired inguinal hernias: Ninety-eight cases (2005–2020)

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Abstract

Objective: To report findings, outcome and determine variables associated with survival in horses with acquired inguinal hernia (AIH).

Study design: Retrospective study.

Animals: A total of 98 cases in 97 horses.

Methods: The medical records (2005–2020) of horses diagnosed with AIH were reviewed. Retrieved data included signalment, history, clinical variables, surgical aspects, postoperative complications, and short- and long-term outcomes. Logistic regression analyses were used to determine factors associated with short-term survival ($p < .05$).

Results: Manual reduction was attempted in a third of the cases (32/98, 33%) and emergency surgery to reduce the hernia was performed in 64 of 98 (65%) cases. Concurrent small intestinal (SI) volvulus was identified in 26 (26/98, 27%) cases. Castration was the most common technique used to prevent recurrence (64/94, 68%). Overall AIH recurrence rate was 11% (11/98). A total of 59 (59/98, 60%) cases survived to hospital discharge and 49 of 52 (94%) cases were still alive after 12 months. Cases admitted within 10 h of colic signs had increased odds of survival (72%) compared to those admitted after 10 h (26%; $p < .001$). Draft breeds ($p = .021$), high heart rate on admission ($p = .001$) and concurrent SI volvulus ($p = .048$) were associated with reduced survival to hospital discharge.

Conclusions: Horses with AIH had a higher risk of concurrent SI volvulus and lower survival than reported. Draft breeds, high heart rate on admission and concurrent SI volvulus were associated with reduced short-term survival.

The preliminary data (48 cases) of this study were presented at the ACVS Surgery Summit, Equine Abdominal Surgery Session, October 2014, San Diego, and at the 22nd Annual Scientific ECVS Meeting, Short Communications, July 2013, Rome, Italy.

Clinical significance: The results of this study should help in prognostication for horses with AIH.

1 | INTRODUCTION

Acquired inguinal hernia (AIH) is a common cause of colic in stallions.[1] This condition is also observed in geldings[2,3] and has been described only once in a mare.[4] Indirect inguinal hernia, in which the intestine protrudes through the vaginal ring into the inguinal canal, is the most common form and is typically unilateral.[1,5] High prevalence of AIH has been reported in some breeds including European Warmbloods, Standardbreds, and Andalusian horses.[6–10] A recent exercise or breeding have been identified as predisposing factors.[8,9,11]

Nonsurgical manual reduction of AIH under general anesthesia has been reported as a single procedure or prior to surgical intervention to address AIH.[1,5–7] An inguinal incision, with or without ventral midline celiotomy, is the conventional surgical approach to reduce the herniated loop of small intestine (SI) into the abdomen.[1,5] Prevention of recurrence is usually accomplished by castration during the emergency surgical procedure.[1,6] Multiple minimally invasive laparoscopic techniques to reduce the internal inguinal ring have been reported in order to preserve the testis while preventing recurrence in stallions, mostly used delayed after initial AIH treatment. These include a transabdominal retroperitoneal mesh insertion technique directly after reduction of AIH,[12] insertion of a cylindrical polypropylene mesh into the inguinal canal,[13] a laparoscopic peritoneal flap hernioplasty (PFH) technique,[6,14] a hernioplasty technique using cyanoacrylate glue,[15] and a tacked intraperitoneal slitted mesh technique.[16]

Reported short-term survival rates for horses with AIH range from 67% to 92%.[7–9,11,17–20] Improvement in survival has been attributed to early referral and prompt surgical intervention[8,9,11,17] but other factors which may explain such variation were not investigated. Some retrospective studies have described the condition[8,9,11,17,20] and investigated specific techniques for reduction and prevention of recurrence.[7,19] However, these studies were partially detailed, descriptive reports,[19,20] or potentially biased by their small number of cases[8,9,11,17] or a particular breed population.[7] Moreover, as far as the authors are aware, a multivariable analysis of the factors associated with outcome has not been performed. A large case series in a mixed-breed population, with various techniques used, is needed to determine factors associated with short-term survival and to help in prognostication for horses with AIH.

The objective of this study was to evaluate clinical findings, surgical techniques used, short- and long-term outcomes and determine prognostic factors associated with short-term survival in adult horses with AIH. Based on clinical observations, we hypothesized that draft horses, cases with a high presenting heart rate, and cases with concurrent SI volvulus would be more represented in nonsurvivors.

2 | MATERIALS AND METHODS

2.1 | Study population

Medical records of horses presented as emergency admission for colic at two European veterinary teaching hospitals (University of Lyon and University of Liège) during the period 2005–2020 were reviewed. Horses <1 year old were excluded. The presence of an AIH was confirmed by identification of a SI loop entering the internal inguinal ring during rectal palpation by the referring veterinarian or on admission, or during surgery or necropsy.

2.2 | Data collection

Signalment, medical history, and duration of colic prior to presentation were retrieved from the medical records for each AIH case. Admission data recorded were pain exhibited (absence, mild, moderate, or severe), heart rate, mucous membrane color (pink, hyperemic, or purple), capillary refill time (CRT), borborygmi (absent, decreased, or normal), abnormality detected on inguinal/scrotal palpation (swelling, testicular changes, abnormal structure, or pain), side affected, findings on rectal examination (SI distension, presence of a SI loop entering the internal inguinal ring, or other abnormality) and presence of nasogastric reflux (>2 L). Ultrasonographic findings, packed cell volume (PCV) and plasma total protein (TP) concentration were also retrieved.

Surgical procedures, approaches, and nonsurgical hernia reduction techniques were recorded. Surgical findings included affected side, hernia or rupture classification, hernia type (incarcerated or nonincarcerated), anatomic location and length of the lesion, and degree of vascular compromise (viable or nonviable) of the intestine involved, performance of intestinal resection and anastomosis, duration of surgery, and presence of any other concurrent abdominal lesions. Any complication that occurred in surgical cases during the hospitalization period was defined as a postoperative complication.

Surgical techniques to prevent recurrence, duration of hospitalization and outcome were recorded.

Short-term survival was defined as the horse surviving to hospital discharge and cases were classified as survivors or nonsurvivors (euthanized). Long-term survival was evaluated as the horse being alive at least 12 months after hospital discharge. Follow-up telephone interviews were conducted with the owners and/or referring veterinarians a minimum of 14 months after discharge. Information obtained included: (1) status of the patient (dead, alive, or lost to follow-up) and if the horse was not alive, date and cause of death; (2) repeat colic or recurrence of AIH following discharge from the hospital; and (3) return to prior or intended use.

2.3 | Statistical analysis

AIH cases were compared with the hospitals' colic population. Data were evaluated for normality by graphic representation, D'Agostino-Pearson test, and Shapiro–Wilk test. Continuous variables were non-normally distributed and were presented as median and range. Categorical data were reported as frequency and percentage. The Mann–Whitney U test was used to compare continuous variables between outcome groups of horses (survivors vs. nonsurvivors at discharge). The Fisher's exact test (2×2 tables) or χ^2-test (larger tables) were used to test for differences between groups for categorical variables. Variables with $p < .20$ in the univariable analysis were used in multivariable logistic regression to determine factors associated with short-term survival. The model was built by initial inclusion of all variables and then refined with forward, backward, and stepwise selection techniques. Results are reported as odds ratios, 95% confidence intervals, and their associated p-value. Data were analyzed with the logistic procedure of SAS version 9.4 (SAS Institute, Cary, North Carolina), and $p < .05$ was considered statistically significant.

3 | RESULTS

3.1 | Demographics

During the study period, 6042 horses were presented for emergency admission with signs of colic of which 2184 (36%) were surgically treated. A total of 98 cases of AIH (University of Liège $n = 52$, University of Lyon $n = 46$) were identified in 97 horses (one horse was presented twice during the study period) resulting in an AIH prevalence of 1.6% (98/6042) of the hospital colic population. Horses surgically treated for AIH represented 2.9% (64/2184) of all horses undergoing surgical treatment for colic. Among stallions that underwent emergency colic surgery, 25% (63/250) were treated for AIH.

There was a significant monthly fluctuation of the number of AIH cases ($p < .001$) not related to the monthly variation of horses undergoing colic surgery ($p = .202$) nor stallions undergoing surgical treatment for colic ($p = .474$). Most of the AIH cases (77/98, 79%) occurred between April and September with the highest prevalence in July with 20 (20%) cases (Figure 1).

The AIH study population consisted of 94 stallions, three geldings, and one mare, with a median age of 7.5 years

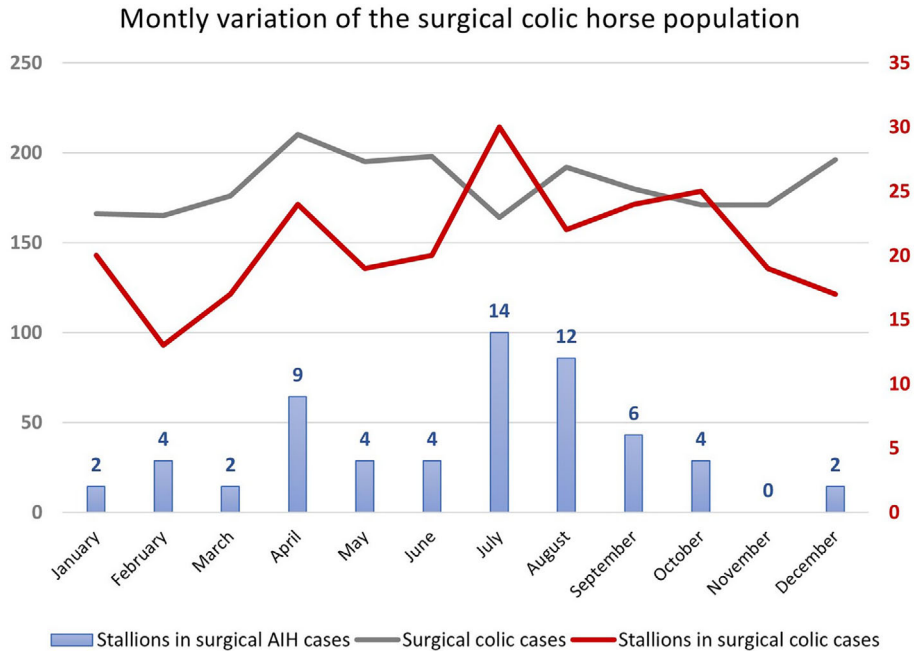

FIGURE 1 Monthly distribution of the surgical colic horse population during the study period.

(range, 2–25) and a median bodyweight of 530 kg (range, 115–900). Breeds included European Warmbloods ($n = 53$), draft horses ($n = 14$), Andalusian horses ($n = 8$), Arabian horses ($n = 7$), French trotters ($n = 6$), ponies ($n = 4$), mixed breed horses ($n = 3$), Camargue ($n = 1$), Lusitano ($n = 1$), and American quarter horse ($n = 1$).

3.2 | History and clinical presentation

The median duration of colic signs prior to presentation was 5.3 h (range, 1–36). A total of 94 (96%) cases had an acute AIH and four cases had a chronic AIH of which one was presented with acute incarceration of the intestine. Chronic cases had a history of mild, intermittent or recurrent colic signs accompanied by the presence of an inguinal or scrotal swelling for 3 days to 3 months before referral. It was noted that colic signs began shortly after exercise or competition in 28 (29%) cases, after breeding in two cases, and after a fall in two other cases. Geldings were castrated at least 6 years before presentation.

Degree of pain was recorded in 96 cases; 25 (26%) had severe pain, 34 (35%) had moderate pain, 13 (14%) had mild pain and 24 (25%) showed no signs of pain. Median heart rate was 48 bpm (range, 30–120). Mucous membranes color was recorded in 95 cases and appeared pink ($n = 55$), hyperemic ($n = 36$) or purple ($n = 4$). Median CRT was ≤2 s for 67 of 93 (72%) cases. Borborygmi were reduced or absent in 80 (80/91, 88%) cases, and normal in 11 (11/91, 12%) cases. An abnormality was detected during external palpation of the scrotum and inguinal region in 98% (90/92) of the cases. The most common local signs were a combination of swelling of the scrotum ($n = 58$) that was firm ($n = 57$), cold ($n = 43$), and painful ($n = 17$). Distended loops of SI were palpated during rectal examination in half of the cases (47/89, 53%). In most cases (63/89, 71%), abnormalities related to the internal inguinal ring were encountered on rectal palpation, including the presence of a loop of SI entering the ring ($n = 54$), enlargement of the ring ($n = 17$), and pain on palpation ($n = 8$). Nasogastric intubation was performed in 84 cases, with no reflux reported in 70 (83%). Transabdominal ultrasound was recorded on half of the cases (50/98, 51%) and distended loops of SI were noted in 32 (32/50, 64%). Ultrasound of the scrotum and inguinal region was performed in 51 cases and revealed the presence of SI in 39 (76%). Median PCV was 40% (range, 26–65) and median TP concentration was 6.9 g/dL (range, 5.2–10.2).

3.3 | Therapeutic procedures

Manual reduction by external manipulation of the scrotum under general anesthesia[5,7,19] was performed in 32 of 98 (33%) cases and was successful in 21 (66%). This procedure was used preoperatively in 19 cases and as a single intervention in 13 cases (Figure 2).

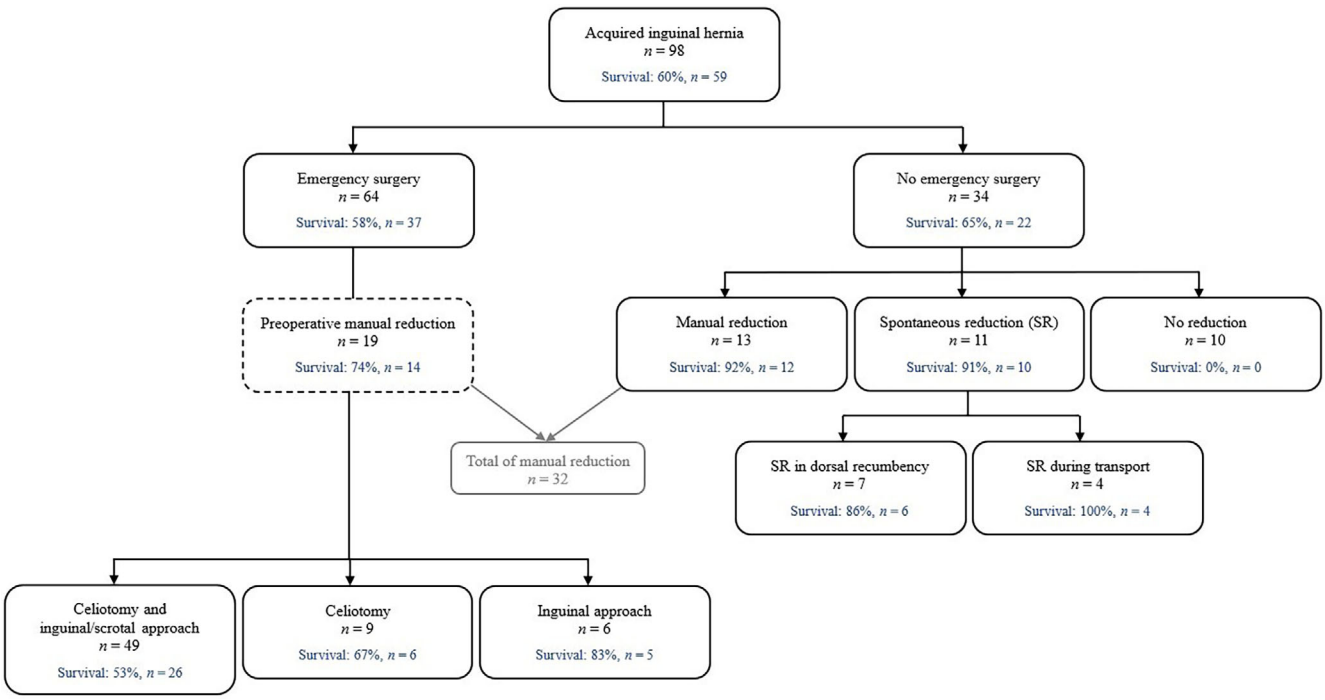

FIGURE 2 Flow chart illustrating the number of acquired inguinal hernia (AIH) cases going through therapeutic procedures and their respective short-term survival.

Overall, 64 of 98 (65%) cases underwent emergency surgery to reduce the hernia. Reduction by a combination of celiotomy and an inguinal ($n = 45$) or scrotal incision ($n = 4$) was the most common surgical technique used (49/64, 77%). Celiotomy was performed in 58 of 64 (91%) cases. Six cases underwent an inguinal approach only. Of the 22 surgical cases in which the incarcerated SI portion was considered nonviable due to vascular compromise, an intestinal resection and anastomosis were performed in 11 (50%) cases, using an end-to-end jejunojejunostomy ($n = 8$), end-to-end jejunoileostomy ($n = 1$), or side-to-side jejunocecostomy ($n = 2$). Among those that underwent an intestinal anastomosis, 55% (6/11) cases survived. The remaining 11 (50%) horses with nonviable SI were euthanized on the table. The median surgical duration was 138 min (range, 60–285) for the 53 of 64 (83%) cases that were allowed to recover from surgery. Of these 53 cases, 47 (89%) developed postoperative complications, resulting in the death of 16 (16/53, 30%). The main postoperative complication was reflux ($n = 31$), followed by colic ($n = 23$), scrotal swelling ($n = 9$), incisional infection ($n = 6$), thrombophlebitis ($n = 6$), diarrhea ($n = 4$), endotoxemia ($n = 3$), myopathy ($n = 3$), peritonitis ($n = 2$), and one of each of recurrence of AIH, hemorrhage after castration, laminitis, pulmonary edema, and pleuropneumonia. Twenty cases had one complication, 17 had two complications, and 10 had multiple complications (range, three to six). Postoperative reflux and colic resulted in a second surgical intervention (celiotomy) for seven (7/53, 13%) cases. Findings in these cases were complication related to the anastomosis site ($n = 3$), SI distention ($n = 2$), and one of each of enteritis at previous site of SI volvulus and hemorrhagic necrosis of the previously incarcerated SI. Among these seven cases, only two survived.

The remaining 34 of 98 (35%) cases did not undergo emergency surgery. In 13 cases the incarcerated AIH was manually reduced by scrotal manipulation under general anesthesia. This procedure was successful in all cases but one and this horse was euthanatized. These successfully reduced cases had a median duration of colic signs prior to admission of 4 h (range, 1–6). None of them required celiotomy during hospitalization. Eleven other cases had nonincarcerated AIH and experienced spontaneous reduction of the hernia when placed in dorsal recumbency at the time of the castration or herniorrhaphy ($n = 7$) or during transport to the hospital ($n = 4$). One of these cases showed recurrence of the hernia and myopathy after castration and herniorrhaphy and was euthanized. The remaining 10 horses were euthanized shortly after admission because of poor prognosis, financial constraints, or unsuccessful attempts to reduce the incarcerated SI by rectal manipulation.

Based on clinical, surgical, and post-mortem findings, most cases had an indirect inguinal hernia (89/98, 91%; including two geldings), five cases (including one gelding) had a ruptured inguinal hernia,[5] and four cases (including the mare) had an inguinal rupture.[5] All AIH were unilateral and AIH occurred more commonly on the left side (55/96, 57%) than on the right side (41/96, 43%). A total of 87 of 98 (89%) AIH were incarcerated and 11 (11%) were nonincarcerated (easily reduced). The anatomical location of the entrapped SI was recorded in 64 cases: ileum ($n = 32$), jejunum ($n = 30$), and jejunum and ileum ($n = 2$). The median length of the entrapped SI recorded in 54 cases was 20 cm (range, 7–200). Concurrent lesions were identified during celiotomy or at necropsy in 55 of 98 (56%) cases and in around half of these cases (26/55, 47%) a SI volvulus was found. All recorded volvuli occurred proximal to the herniated loop of SI and in nine of 26 (35%) cases the SI included in the volvulus was judged as nonviable due to vascular compromise. The other concurrent lesions included large colon impaction ($n = 16$), displacement of the large colon ($n = 8$), gastric rupture ($n = 3$), distended stomach ($n = 2$), hemoperitoneum ($n = 2$), mesenteric tear ($n = 2$), hydrocele ($n = 2$), and one of each of testicular cord hemorrhage, testicular neoplasia, and adhesion between SI and the testis. Castration was used to prevent recurrence of the AIH in most stallions (64/94, 68%). Castration was bilateral (48/64, 75%) or unilateral on the AIH side only (16/64, 25%). Bilateral standing laparoscopic PFH was performed in two cases, one after recurrence following castration and one after successful manual reduction. The remaining stallions did not undergo any surgical procedure to prevent recurrence of the AIH in accordance with the owners' wish ($n = 9$) or because of euthanasia ($n = 20$). The median hospitalization time for cases that were discharged was 10 days (range, 3–37).

3.4 | Outcome

A total of 59 of the 98 cases were discharged from the hospital, resulting in a short-term survival rate of 60%. Cases were euthanized on admission ($n = 10$), after unsuccessful manual reduction of the AIH ($n = 1$), following complications after castration ($n = 1$), during emergency surgery ($n = 11$), and in the postoperative period because of complications ($n = 16$). Thirty-seven of the 53 (70%) cases that recovered from emergency surgery survived to discharge.

3.5 | Prognostic factors associated with short-term survival

Tables 1 and 2 present factors associated with survival to hospital discharge in the univariable analysis. None of

TABLE 1 Univariable associations between continuous variables and AIH cases that did survive and those that did not survive to hospital discharge.

Continuous variable	Survival, $N = 59$	Nonsurvival, $N = 39$	p-value
Weight (kg)	512 (115–860), $n = 57$	550 (374–900), $n = 35$	<.001
Presentation after onset of clinical signs (hours)	4.8 (1–27.5), $n = 56$	10 (2–36), $n = 39$	<.001
Heart rate (beats/min)	44 (30–80), $n = 57$	68 (36–120), $n = 39$	<.001
Packed cell volume (%)	38 (26–59), $n = 53$	46 (27–65), $n = 37$	.004
Total protein (g/dL)	6.7 (5.5–8.5), $n = 52$	7.4 (5.2–10.2), $n = 31$	.008
Hospitalization duration (days)	10 (3–37), $n = 59$	1 (1–25), $n = 39$	<.001

Note: Only significant variables ($p < .05$) are included in the table.
Abbreviation: AIH, acquired inguinal hernia.

the remaining variables were associated with short-term survival. There was a significant difference between survivors and nonsurvivors for the duration of the colic signs before hospital admission ($p < .001$). Survival rate for cases admitted to the hospital within 10 h from the onset of colic was 72% compared to 26% for those admitted after 10 h ($p < .001$). Breed distribution was different between survivors and nonsurvivors ($p < .001$) and only one of the 14 (7%) draft horses survived. None of the cases with a presenting heart rate ≥84 bpm survived ($n = 9$). Most cases (10/11, 91%) with a nonincarcerated hernia survived compared to 56% (49/87) with an incarcerated hernia ($p = .046$). Among cases that underwent surgery, the viability of the incarcerated SI was significantly different between survivors and nonsurvivors ($p < .001$). Most cases (49/61, 80%) without vascular compromise of the SI (viable) survived, compared to 23% (6/26) cases with vascular compromise of the SI (nonviable). Moreover, cases with a concurrent SI volvulus had an increased risk of nonsurvival (62%) compared to those without SI volvulus (25%).

In the final multivariable logistic regression model (Table 3), the factors associated with an increased risk of nonsurvival to hospital discharge included draft breeds ($p = .021$), higher heart rate on admission ($p = .001$), and presence of concurrent SI volvulus ($p = .048$). Draft horses had a decreased odds ratio of surviving by 0.057 times compared to other breeds. Absence of SI volvulus increased the odds of surviving by 3.761 times compared to cases with SI volvulus. Odds of surviving decreased by 0.928 per unit increase in heart rate on admission.

3.6 | Long-term follow-up

Long-term outcome was available for 52 of 59 (88%) cases discharged from the hospital. Median follow-up was 82 months (range, 14–182). A total of 49 (49/52, 94%) cases were still alive at least 12 months after discharge. Two horses were euthanized for reasons related to the AIH, one for colic associated with focal perforation of the ileum at the location of the AIH with peritonitis diagnosed on necropsy 5 days after discharge, and one for persistent postanesthetic pleuropneumonia 5 months following hospital discharge. The remaining horse died from an unknown cause without prior signs of colic 40 days after discharge. A total of 17 (17/52, 33%) cases were reported to have experienced at least one episode of colic following discharge and eight (47%) of these cases required a celiotomy. Forty-six of 52 (88%) cases returned to some athletic performance after discharge, with 83% (43/52) returning to their previous, higher, or intended level, and 6% (3/52) cases returning to a lower level of performance.

3.7 | Recurrence

In total, 11 (11%) of all cases experienced recurrence of AIH, prior to presentation ($n = 5$), during hospitalization ($n = 3$), or after hospital discharge ($n = 3$, including the horse presented twice during the study period). Three cases presented with recurrence of AIH after successful manual reduction, either 1 day ($n = 2$) or 3 months ($n = 1$) after reduction. Recurrence was found in four other cases after surgical reduction: two that underwent bilateral castration, one that underwent unilateral castration (recurrence on the noncastrated opposite side) and one without castration. The times to recurrence were 3 h, 36 h, 5 years, and 19 months, respectively. The remaining four recurrences developed at a median time of 11 months (range, 3–21) following bilateral standing laparoscopic procedures to reduce the internal inguinal ring (two PFH, one procedure with glue and staples, and one direct suture of the peritoneum with barbed suture). In all cases but one AIH recurred on the same side.

TABLE 2 Univariable associations between categorial variables and AIH cases that did survive and those that did not survive to hospital discharge.

Categorical variable	Survival, *n* (%)	Nonsurvival, *n* (%)	*p*-value
Breed			<.001
Warmblood	37 (70)	16 (30)	
Draft	1 (7)	13 (93)	
Other	21 (68)	10 (32)	
Presentation after onset of clinical signs			<.001
<10 h	48 (72)	19 (28)	
≥10 h	7 (26)	20 (74)	
Pain			.009
Absent	19 (79)	5 (21)	
Mild	9 (69)	4 (31)	
Moderate	22 (65)	12 (35)	
Severe	9 (36)	16 (64)	
Distended SI at rectal palpation			.005
Yes	21 (45)	26 (55)	
No	31 (74)	11 (26)	
Lesion			<.001
Nonviable	6 (23)	20 (77)	
Viable	49 (80)	12 (20)	
Incarceration			.046
Incarcerated	49 (56)	38 (44)	
Nonincarcerated	10 (91)	1 (9)	
Concurrent lesion			.019
Yes	29 (53)	26 (47)	
No	30 (77)	9 (23)	
SI volvulus			.002
Yes	10 (38)	16 (62)	
No	47 (75)	16 (25)	
Complications during hospitalization			<.001
Yes	35 (67)	17 (33)	
No	24 (100)	0 (0)	

Note: Only significant variables ($p < .05$) are included in the table.
Abbreviation: AIH, acquired inguinal hernia; SI, small intestine.

TABLE 3 Multivariable analysis results determining factors associated with short-term survival in 98 AIH cases.

Variable	OR	95% CI	*p*-value
Breed, draft vs. others	0.06	0.01–0.74	.021
Heart rate	0.93	0.89–0.97	.001
SI volvulus, presence	3.76	1.01–14.02	.048

Abbreviations: AIH, acquired inguinal hernia; CI, confidence interval; OR, odds ratio; SI, small intestine.

4 | DISCUSSION

As hypothesized, short-term survival for horses with AIH was adversely affected in draft breeds, high presenting heart rate and concurrent SI volvulus. The high mortality rate (13/14, 93%) of the draft horses in this study appeared to be related to the late presentation of these patients (median of 13.5 h; range, 4–36 after onset of colic signs). Our clinical impression is that the stoical nature of draft horses contributed to the delay in the decision to refer these cases for surgery. Moreover, heavy draft horses develop more postoperative complications with a higher mortality rate than lighter breed horses.[1] This information agrees with our findings, with six of 14 (43%) draft horses euthanized in the postoperative period. The study also found that short-term survival decreased with an increasing heart rate on admission as confirmed in other studies.[1,8,18] This significant association reflects the fact that horses with strangulating SI lesions rapidly develop cardiovascular compromise.[18] Another factor associated with nonsurvival was the presence of a concurrent SI volvulus. Similar to the study by Baranková et al.,[7] AIH cases with SI volvulus had an increased risk of mortality. SI volvulus was the most common concurrent lesion associated with AIH noted in more than a quarter (27%) of our cases. It has been generally accepted that SI volvulus may occur secondary to AIH because an entrapped SI loop provides an axis around which the volvulus can develop.[21] Duration of the incarceration may lead to increased risk of fluid and gas distension of the SI and, therefore, volvulus. This assumption is supported by the results of a recent study in which only 7% of the horses undergoing immediate celiotomy had SI volvulus compared to 60% of horses undergoing delayed surgery.[7] However, no direct relation between the duration of the colic signs and the presence of SI volvulus was found in our study. For the above reasons, and because AIH was accompanied by concurrent gastrointestinal lesions in around half of the cases in this study, celiotomy remains an important therapeutic step and should be considered on an individual basis.

During the study period, a quarter of the stallions that underwent emergency colic surgery were diagnosed with AIH. In addition, based on current and previous studies,[4,8,17] AIH should still be considered in the differential diagnosis of SI strangulation in geldings and mares. To our knowledge, this study is only the second report of an inguinal rupture in a mare. Interestingly, both mares were elderly and in a debilitated condition.[4] European

Warmbloods (53/98, 54%) were over-represented with regard to the mixed breed hospital surgical colic population of our study, which confirmed this breed predisposition.

The seasonality of the condition has previously been identified,[8,9,20] and Muñoz et al.[10] reported a 30-fold increase in the risk of AIH during summer in Spain. The predominance of AIH cases in spring/summer coincides with a period of increased competition and breeding activity for stallions. It is assumed that exercise or breeding may contribute to herniation by altering the anatomy of the inguinal canal and increasing abdominal pressure.[5,8]

AIH occurred slightly more commonly on the left side in our study, which is consistent with previous studies.[6–9,17,19,20] The reason is unknown but may be related to a larger left vaginal ring due to the larger size of the left testis.[5] Distal jejunum, ileum or both regions are typically involved in AIH,[5,7,9,17,20] which can be explained by their longer mesentery allowing free mobility throughout the abdominal cavity.[3] The reduced prognosis of jejunocecostomy necessary when the ileum was involved may explain the high proportion of cases with nonviable SI euthanized on the table (ileum in 7/11 cases vs. 1/11 in the resection and anastomosis cases).

A recently published study on manual reduction has reported a success rate of 90%.[7] This high success rate could be explained by the case profile of Warmblood horses that may have a wider inguinal canal than other breeds and short referral times linked to the specific hospital population with less damaged SI.[7] Manual reduction seems especially appropriate and successful when the duration of colic signs is less than 4 h.[7,20] This procedure performed preoperatively offers the benefit of giving the herniated SI to recover before being visually assessed during the subsequent celiotomy.[19] Manual reduction can be attempted to avoid the need for surgical intervention. However, surgeons should be aware of the potential need for delayed celiotomy in up to 17% of the cases and the risk of higher mortality rate.[7] Based on our experience, manual reduction not followed by celiotomy should be restricted to horses without SI distention on rectal palpation or transabdominal ultrasound in order not to miss a concurrent SI volvulus. Further investigation is needed to determine specific selection criteria for horses that require a celiotomy following manual reduction.

Our postoperative complication rate seems higher than that of previous reports.[11,20] This may be due to the fact that all types of complications, even minor ones, were counted in this study. Previous studies have highlighted that AIH carries a high risk of necessitating a second surgical intervention (24%).[10] Similarly, seven cases underwent a second surgery in our study.[9,11,17]

The overall recurrence rate of AIH was 11% which is comparable to previous reports.[7] Ipsilateral recurrence was most common, but AIH may develop on the opposite side years following the initial episode.[16,17] Owners should be aware of this risk when debating the use of unilateral intervention to prevent the recurrence of AIH. In our study, as in other reports,[8,11,17,20] castration was the preferred technique to prevent recurrence. Laparoscopic procedures, although performed in both hospitals, were not commonly chosen. Recurrence of AIH has been reported in stallions left intact,[8,9,17] following castration,[17] and after laparoscopic PFH.[6,7,19] Interestingly, in this case series, recurrence developed under each circumstance; after manual reduction, following surgical reduction without castration, subsequent to castration or after various laparoscopic procedures. Recurrence of AIH after castration is uncommon and the only two cases that recurred on the castrated side occurred in the early postoperative period (within 36 h) in this study. Castration lowers the risk of developing AIH because vaginal rings constrict following testis removal.[3,5] Nevertheless, the presence of geldings in our study underlines the potential of occurrence or recurrence of the AIH even long after castration. In this study, both cases that experienced recurrence after laparoscopic PFH occurred before the technique was modified by Wilderjans et al.[6] to cover the vaginal ring fully. Laparoscopic techniques are continually being developed and refined to improve surgical efficiency and decrease recurrence risk.

Our short-term survival rate of 60% was lower than that of previous reports.[7,20] Some authors have suggested that prognosis for AIH may depend on the duration of colic signs prior to admission,[3,4,8] which may partially explain our results since the median duration of colic signs before hospital arrival was longer in this study than in another report[7] with a lower mortality. Moreover, we found that horses had a significantly better prognosis for survival if treated within 10 h of onset of signs (72% vs. 26%). However, this parameter did not remain in the final statistical model for short-term survival. Long-term survival was excellent for cases discharged from the hospital and horses had a good prognosis to return to previous or higher level of performance. However, a third of the cases experienced signs of colic after discharge. Intermittent colic is a common complication after SI surgery and is most likely the result of adhesion formation.[1] Adhesions of the SI were observed in two cases during hospitalization, one at repeated celiotomy and one at necropsy.

This retrospective study had inherent limitations including incomplete medical records, horses lost to follow-up, and reliance on owners/veterinarians for follow-up data. An additional limitation of this two-center study was that conditions were not standardized. European horse population, variation in clinical assessment, lack of treatment randomization, and disparity in case management may have led to bias within the study.

Surgical assessment of the SI lesions was subjective and may differ among the contributing surgeons.

In conclusion, AIH is a common cause of colic often requiring surgery in stallions and the condition has a peak incidence during the summer. The surgeon should be aware of the potential risk of concurrent SI volvulus. Recurrence of AIH is a concern and bilateral surgical techniques to prevent recurrence are recommended. Short-term survival was fair and long-term survival was excellent for horses discharged from the hospital. Duration of colic signs of more than 10 h is associated with a poor prognosis for survival. Other prognostic factors associated with reduced survival to hospital discharge were draft breeds, high presenting heart rate and concurrent SI volvulus. The results of this large case series provide evidence that should help clinicians in the management and prognostication of horses with AIH.

AUTHOR CONTRIBUTIONS

François I, DVM, DECVS: Study organization, data collection and analysis, manuscript preparation. Lepage OM, DVM, PhD, DECVS: Data collection, manuscript revision. Schramme MC, DVM, PhD, DECVS, DACVS: Data collection, manuscript revision. Salciccia A, DVM, PhD, DECVS: Data collection, manuscript revision. Detilleux J, DVM, PhD, MSc: Statistical analysis, manuscript revision. Grulke S, DVM, PhD, DECVS: Study design, data collection and analysis, manuscript preparation. All authors approved the final version of the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest related to this report.

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