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Assessment of diagnostic markers and surgical outcome in horses treated for intestinal colic

JOBAN JOT SINGH[1]✉, JASMEET SINGH KHOSA[1], ARUN ANAND[1], JITENDER MOHINDROO[1] and VANDANA SANGWAN[1]

Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab 141 004 India

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ABSTRACT

To support the decision-making process for the surgical intervention in equine patients suffering from intestinal colic, the present clinical study was conducted on ten horses (5 males and 5 females) aged 3 months to 8 years. An exploratory celiotomy was performed on patients with moderate to severe persistent abdominal pain, a lack of response to treatment, and the absence of intestinal borborygmi. Preoperative physical assessment (heart rate, respiration rate, mucus membrane perfusion, capillary refill time), haemato-biochemical analysis, and peritoneal fluid analysis helped in reaching a decision for surgical intervention as diagnostic indicators. Pre- and post-operative ultrasonography was also performed on the patients. Blood lactate level was significantly higher in non-survivors (9.94 mmol/L) than in survivors (4.32 mmol/L). In survivors, peritoneal fluid showed an increase in degenerative neutrophils, and total protein, and there was a decrease in lactate level post-operatively. Presence of small colon fecolith (n=4) was determined to be the primary cause of colic, followed by pelvic flexure impaction (n=2), caecum impaction (n=1) and right dorsal displacement of large colon (RDDLC) (n=1). Strangulating lesions such as small intestinal volvulus (n=2) was also recorded. The most common post-operative complication was sub-cutaneous seroma (n=2) which subsided on its own in a week or so. Surgical interventions helped to save the lives of 50% of the patients who were successfully discharged from the hospital; remarkably, all of them survived and returned to their normal functionality, as observed in the long-term follow-up.

Keywords: Diagnostic indicators, Exploratory celiotomy, Fecolith, Impaction, Lactate, Peritoneal Fluid, Ultrasonography

Equines, particularly horses, are among the most important animals in human history. They have been indispensable in traditional wars and also as a reliable and relatively fast means of transport. As per the 20th Livestock Census (Department of Animal Husbandry 2019), the total population of equines in India was 0.54 million (1.14 million in the year 2012), which comprised horses and ponies (0.34 million), donkeys (0.12 million), and mules (0.08 million). However, exports and imports of horses increased remarkably in spite of this downward trend in the equine population in India. Colic is a major cause of morbidity and mortality, premature deaths, and is the number one health concern in equine (Bihonegn and Bekele 2018). It results from the accumulation of gas, intestinal displacement, impacted food mass, parasites, and also some risk factors (breed, age, management factors) (Radostits *et al*. 2007). Basic clinical characteristics obtained through physical observations and some diagnostic procedures serve as the foundation for identifying the animal which requires medical or surgical therapy. Abdominal ultrasonography is very helpful for imaging abdominal organs such as the liver, spleen, and urogenital system, as well as investigating acute intestinal issues, recurring colic, and weight loss in a mature horse (Busoni *et al.* 2011). It offers a rapid and effective structural and functional evaluation of horses with signs of colic for prompt action (Pessoa *et al*. 2023). An early and prompt diagnosis of this problem can help save the life of this precious animal (horse) and avoid monetary loss to the owner as well. The present study was, therefore, conducted with an objective of evaluating diagnostic indicators, surgical findings, and the post-operative outcome of equine colic.

Present address: [1]Department of Veterinary Surgery and Radiology, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab. ✉Corresponding author email: jobanjotsingh@gmail.com

MATERIALS AND METHODS

The study was conducted on ten horses (5 males and 5 females), aged 3 months to 8 years referred for surgical intervention.

An exploratory celiotomy was conducted on the patients experiencing moderate to severe persistent abdominal pain and abdominal distension, a lack of response to medical treatment, abnormal physical examination findings like absence of intestinal borborygmi, and per rectal findings.

The horses underwent premedication with xylazine (1.1 mg/kg b.wt, i.v.), and anesthesia was induced after 10 min with ketamine (2.2 mg/kg b.wt, i.v.). Endotracheal intubation was performed, and anaesthesia was maintained with 2% isoflurane in a partial rebreathing system. The horses were positioned in dorsal recumbency, and a broad ventral midline area was prepared for aseptic surgery. The surgical site was thoroughly scrubbed and draped, and a midline celiotomy incision of approximately 25-30 cm was made between the umbilicus and xiphoid to access the abdominal cavity. Upon opening the abdomen, a systematic exploration was conducted to identify the nature of the colic problem and take necessary corrective actions. This was followed by the replacement of the intestines in their normal anatomic orientation. The abdominal cavity was lavaged, and the abdomen was closed in a routine manner.

Post-operatively, fluid therapy, antibiotics, and analgesics were administered. Flunixinmeglumine (Virbac Animal Health India Pvt Ltd) were given (1.1 mg/kg b.wt, i.v., b.i.d.) for four days post-operatively. Antimicrobial therapy included a combination of piperacillin-tazobactam (Abbott Healthcare Pvt Ltd - 50 mg/kg b.wt, i.v., b.i.d.), amikacin (Ranbaxy Lab. Ltd - 10 mg/kg b.wt, i.v., OD), and metronidazole (Pfizer Animal Health Ltd. - 10 mg/kg b.wt, i.v., b.i.d.) for 10 post-operative days. Blood collected in EDTA vials was immediately used to determine haemoglobin (g%), packed cell volume (PCV%), and total leukocyte count (TLC) using the ADVIA Hematology System (Siemens). Blood smears were prepared and evaluated for differential leukocyte count (DLC) after staining the slides with Wright's stain. Blood samples were collected to compare blood parameters between survivors and non-survivors. Serum biochemistry was done for lactate, total protein and glucose using VITROS DT-II Chemistry System (Ortho-Clinical Diagnostics, Johnson and Johnson).

RESULTS AND DISCUSSION

It was found that in the young foals of less than 1 year of age (n=4), small colon faecolith (n=2) acted as the primary cause of obstruction leading to intestinal colic. In remaining two foals, one had right dorsal displacement of large colon (RDDLC) as the primary anomaly and the other had a small intestinal strangulating inguinal hernia. Earlier findings indicated that young foals under the age of one year were observed to experience small colon obstructions (Haupt *et al*. 2008).

As per the record of present study, 70 % of the horses (n=7) had a history of either wheat straw feeding or history of daily grain feeding in excess of 2 kg. Coarse roughage with low digestibility, or notably coarse fibre, has been reported to be associated with impaction colic, as noted by Khosa *et al*. (2023). Three horses (out of 10) ingested concentrates in excessive amounts of more than 2 kg. A recent change in the type or amount of concentrate fed has been identified as a potential factor increasing the risk of colic, as indicated by Singh *et al.* (2021). Inferences from the study revealed that only 30% (n=3) equines had a history of regular deworming.

Among the 10 horses in the study, two exhibited colic lasting for exactly 48 h, while the remaining eight had colic episodes lasting longer than 48 h. Colic was observed to be severe in three of the non-surviving cases and in one survivor with evident injury marks. Colic episodes exceeding 48 h were linked to specific conditions such as caecal impaction leading to unknown intestinal rupture, right dorsal displacement of the large colon (RDDLC), torsion at the mesenteric root of the ileum, and small colon fecolith. Abdominal distension also served as a crucial criterion for determining whether a horse required surgical intervention. Abdominal distension was observed to be moderate to severe in cases with complete obstruction or in horses with a more extended duration of clinical signs of abdominal pain. Furthermore, it was found to be severe in two cases that did not survive and two that did survive, while the remaining cases exhibited mild to moderate abdominal distension. Abdominal pain and distension are key characteristics that indicate the need for abdominal surgery in horses, as recommended by Gitari *et al.* (2017). Mean heart rate of survivors was found to be significantly higher as compared to non-survivors (Table 1). Southwood *et al.* (2010) found that in colic patients, tachycardia up to 60 beats per min (bpm) can be associated with pain. Based on this observation, it could be opined that a heart rate of 70 bpm or higher, as observed in the present study, might have resulted in level of shock in the affected patients. The respiration rates of all colic patients were found to be 27.80±2.76 per minute, whereas in non-survivors, it was summed up to be significantly higher than survivor horses (Table 1). Pain and significant abdominal distension are the most frequent causes of a high respiratory rate, as they exert pressure and result in an elevated respiration rate, as noted by Southwood *et al*. (2010). The respiratory rate was observed to decrease significantly over the course of the postoperative period and return to normal limits by the time of discharge.

Table 1. Mean±SE values of temperature (*f), heart rate (per min) and respiratory rate (per min) in survived and non- survived animals.

Variable	Survivors (N=5)	Non-Survivors (N=5)
Temp (°F)	101.56 ± 0.48	100.66 ± 0.84
Heart rate (bpm)	76.80 ± 4.55	92.00 ± 5.15
Respiratory Rate (per minute)	22.40 ± 2.79	33.20 ± 3.46

Haematological and biochemical parameters were assessed in both survivors and non-survivors (Tables 2 and 3). Serum lactate levels were assessed during both pre- and post-operative periods, and it was determined that these values were highly significant as diagnostic and prognostic indicators for colic-affected horses. As per inferences drawn in the study, the mean serum lactate levels in

Table 2. Haematological parameters (mean±standard error) in survivor and non-survivor horses

Variable	Survivors	Non survivors
Haemoglobin (g%)	13.64±1.24	13.14±1.08
TLC (cumm)	13440±2342.3	12987.8±2561.1
PCV (%)	36.00±1.52	38.20±1.83
Neutrophil (%)	80.40±1.17	71.00±3.58
Lymphocyte (%)	19.60±1.17	29.00±3.58

non-survivors were found to be significantly higher as compared to the survivors (Table 3). Apart from this, it was also observed that lactate levels were elevated before surgery and significantly decreased in survivors following the surgical procedure. In a prospective observational study conducted by Tennet-Brown (2010), involving 250 adult horses presented for emergency situations; it was observed that plasma lactate concentration was significantly higher at admission in non-survivors as compared to survivors. This finding further underscores the value of lactate concentration as a prognostic indicator in emergency cases involving horses.

Transcutaneous abdominal ultrasonography could be a reliable and faster tool for assessing intestinal motility, identifying pockets of peritoneal fluid for abdominocentesis, and diagnosing small intestinal distension and wall thickening (Waxman 2020) (Supplementary Table 1). In the present study, pre-operative ultrasound examinations were conducted in 8 out of the 10 horses, as two of them were uncooperative due to pain and couldn't undergo the pre-surgery ultrasound. Survivors showed a small amount of free fluid, whereas non-survivors exhibited a notably increased amount of free fluid compared to the survivors (Fig. 1). This increased free fluid could potentially lead to peritonitis. In all cases that underwent preoperative ultrasound, distension of the colon was observed. In all cases, both the kidney and spleen were simultaneously visible in the nephrosplenic window, eliminating the possibility of nephrosplenic entrapment in any of the cases. FLASH (fast localized abdominal sonography of horses) could rapidly diagnose intestinal abnormalities and the presence of free abdominal fluid within 15 minutes, facilitating early decision-making for surgery (Busoni *et al.* 2011).

During exploratory laparotomy, fecolith obstruction (n=4) was identified as the main cause (Supplementary Table 2). In the four horses with fecolith obstructions in the small colon, enterotomy was performed to remove the fecolith in only one horse while in the other three cases, the fecoliths were crushed through kneading, which ultimately cleared the passage for the movement of digestible matter/ ingesta (Fig. 2). Three of them survived while, one

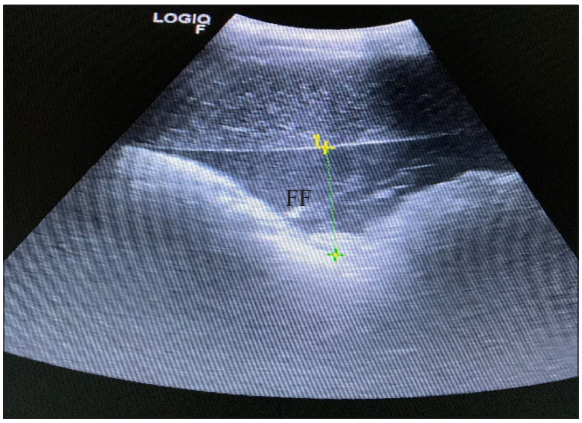


Fig. 1. Free fluid (FF) seen between intestinal loop.

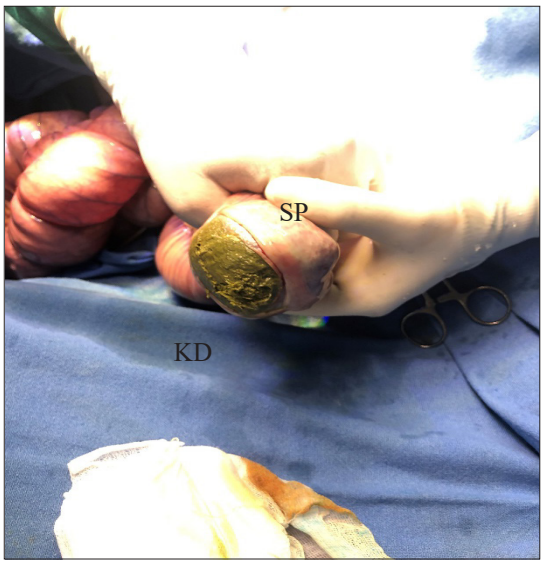
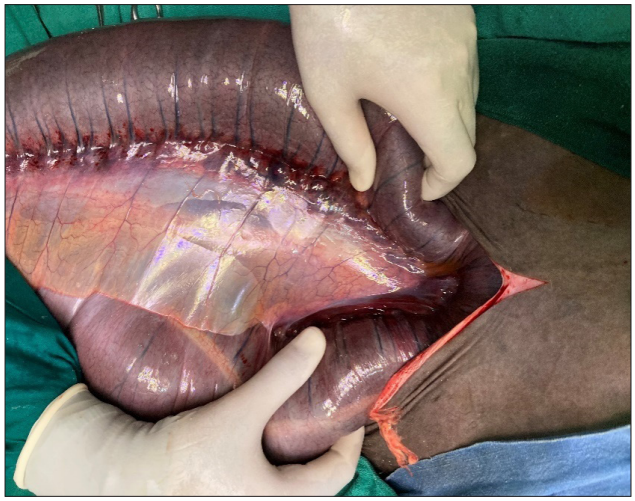


Fig. 2. Intra-operative photograph showing fecolith obstruction of small colon, enterotomy is being performed on the antimesenteric band to remove the fecolith.

Fig. 3. Impaction of pelvic flexure seen in two equine colic patients.

Table 3. Biochemical parameters (mean±standard error) in survivor and non-survivor horses

Horse	TP g/dL	Na mEq/L	K mEq/L	Cl mEq/L	Lactate mmol/L	Glucose mg/dL
Survivor N=5	7.12± 0.22	146.20±2.63	3.92±0.33	99.80±3.09	4.32±0.99	144.60±6.33
Non survivor N=5	6.44±0.42	144.00±2.55	5.32±0.77	101.80±0.66	9.94±0.56	172.40±4.12



(A)

(B)

Fig. 4. Right dorsal displacement of large colon (RDDLC): (A) the large colon is exteriorized and (B) the displacement is corrected.

unfortunately did not. The major cause of fecolith impaction in the present study was feeding on wheat straw. Inferences from the present study revealed that 30% of the horses (3 out of 10) had issues primarily involving the large colon as the cause of their intestinal obstruction. This included two cases of pelvic flexure impaction (n=2) (Fig. 3) and one case of right dorsal displacement (n=1) (Fig. 4). Large colon impaction was the second most commonly reported cause of colic in horses, with tympany being the most frequent type of simple obstruction (Khosa *et al.* 2023). Cecum as a primary cause of colic was found in 10% (n=1) horses in the study. According to Velloso Alvarez *et al.* (2021), cecal impaction is a relatively common pathological condition affecting the cecum, accounting for approximately 5% of horses with intestinal impactions and up to 4.1% of horses seen at referral hospitals for colic. Findings on exploratory laparotomy included caecum impaction (n=1) (Supplementary Fig. 1). Two cases (20%) were identified with small intestine issues and findings during exploratory laparotomy included strangulation due to volvulus (n=2) (Supplementary Fig. 2). The current study observed a higher survival rate in cases involving affections of the small and large colon compared to those affecting the small intestine or cecum, aligning with findings reported by Morton and Blikslager (2002).

Out of ten, five horses were discharged from the hospital, resulting in a short-term survival rate (discharge from the hospital) of 50%. Remarkably, all five of these discharged cases survived. These surviving horses not only recovered but also returned to their normal functionality. The long-term survival rate for horses that underwent colic surgery was also estimated at 50%, and all of these horses returned to their normal functions during long-term follow-up.

In conclusion, diagnostic features like increased heart rate, respiratory rate, markedly elevated lactate values, severe abdominal pain, and abdominal distension are diagnostic indicators for equine colic. Pelvic flexure impaction and small colon fecolith affections have a good surgical outcome, whereas small intestine strangulation and right dorsal displacement of the large colon have a poor prognosis.

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