Case Report Rapport de cas

Ileal impaction and jejunal enterotomy in a 4-month-old Arabian filly

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Abstract — A 4-month-old Arabian filly was treated by surgical correction of an ileal impaction. The impaction was resolved through a distal jejunal enterotomy. One-year follow-up showed no post-operative complications secondary to the enterotomy. Jejunal enterotomy may be a surgical option for resolution of an ileal impaction.

Résumé — Surcharge iléale et entérotomie jéjunale chez une pouliche Arabe âgée de 4 mois. Une pouliche Arabe âgée de 4 mois a été traitée par la correction chirurgicale d'une surcharge iléale. La surcharge a été résolue par une entérotomie jéjunale distale. Un suivi d'un an n'a pas montré de complications postopératoires suite à l'entérotomie. L'entérotomie jéjunale peut représenter une option chirurgicale pour la résolution d'une surcharge iléale.

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Ileal impaction is the most common non-strangulating obstruction of the small intestine by ingesta without obstruction of vascular flow (1,2). Extraluminal massage of the impaction to facilitate passing of the ingesta into the cecum has become the surgical treatment of choice due to complications associated with bypass procedures (1,3). We report the diagnosis of an ileal impaction in a 4-month-old Arabian filly, the youngest reported. In addition, we describe the use of a distal jejunal enterotomy procedure which may limit post-operative complications.

Case description

A 4-month-old Arabian filly was presented to Auburn University Large Animal Teaching Hospital Emergency and Critical Care Service for clinical signs of colic of approximately 1 d duration. Treatments administered by the owner prior to admission included intramuscular injections of flunixin meglumine, which failed to provide relief of the abdominal discomfort. The foal's husbandry consisted of pasture turnout with her dam and 3 additional mare/foal pairs, with access to coastal Bermuda hay. The foal had not experienced any previous medical problems, but had received multiple doses of an alfalfa-pelleted piperazine dewormer 1 d, 4 wk and 6 wk prior to presentation.

On presentation, the filly was quiet and depressed, with significant abdominal distention. Her physical examination parameters were within normal limits with the exception of slightly injected mucous membranes, tachycardia (60 beats/min), and decreased borborygmi in all 4 abdominal quadrants. The filly was sedated with xylazine (Anased; Lloyd Laboratories, Shenandoah, Iowa, USA), 1.1 mg/kg body weight (BW), intravenously (IV) in order to perform the additional components of the colic examination.

Nasogastric intubation was performed and resulted in no net reflux. Ultrasonography of the abdominal cavity revealed multiple loops of distended, non-motile small intestine ranging from 4 to 5 cm in diameter with no evidence of intramural thickening. Gross appearance of the peritoneal fluid was clear, straw-colored with a total nucleated cell count of 85 000 cells/L and a total protein of 12 g/L. The results of a complete blood cell count and serum chemistry panel (including electrolytes, blood urea nitrogen, creatinine, glucose, and lactate) were within reference ranges, with the exception of an elevated packed cell volume [46%; reference range (RR): 32% to 43%] (4) and an elevated peripheral lactate of 4.0 mmol/L (RR: 0.38 to 1.12 mmol/L).

Based on the abdominal distention, ultrasonographic findings, the abnormal cell count of the peritoneal fluid, as well as failure to respond to analgesia, an exploratory laparotomy was recommended. Differential diagnoses for the filly's signs of colic prior to surgery included 1) small intestinal obstruction due to ascarid impaction, based on age and history of piperazine administration, 2) ileal impaction, due to history of access to coastal Bermuda hay, or, less likely, 3) a strangulating lesion, based on the abnormal cell count of the fluid from the abdominocentesis and level of discomfort.

Prior to anesthesia, the filly was administered potassium penicillin (Phizerpen; Pfizer, New York, New York, USA), 22 000 U/kg, BW, IV, gentamicin sulfate (GentaVed 100; Vedco Inc, Saint Joseph, Missouri, USA), 6.6 mg/kg BW, IV, and a tetanus antitoxin as well as a tetanus toxoid intramuscularly. The

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filly was sedated with xylazine (1.1 mg/kg BW, IV) and butorphanol tartate (Butorphic; Lloyd Laboratories), 0.05 mg/kg BW, IV, and anesthesia was induced with ketamine hydrochloride [Ketavet, Fort Dodge (Pfizer)], 2 mg/kg BW, IV and diazepam (Diazepam; Hospira, Lake Forest, Illinois, USA), 50 mg/kg, BW, IV. The filly was placed in dorsal recumbency and maintained under general anesthesia using isoflurane in oxygen with a semi-closed anesthesia circuit. The patient's ventral abdomen was prepared in a routine manner, and a 16-cm incision originating at the umbilicus and extending cranial was made through the skin and linea alba. Most of the small intestine was moderately distended with gas and fluid, and the source of the colic was determined to be a feed impaction affecting the ileum and extending orally approximately 20 cm from the ileocecal orifice.

Due to the extensive nature of the impaction and the increased incidence of adhesions noted in foals after exploratory laparotomy (5), a jejunal enterotomy was selected to reduce handling and time under anesthesia. A section of distal jejunum just oral to the ileum was exteriorized and isolated from the abdomen using an impervious drape (split sheet "U Drape;" Veterinary Surgical Resources, Darlington, Maryland, USA) and moistened sterile towels. A 6-cm, linear enterotomy was performed on the anti-mesenteric border of the jejunal loop. To decrease the amount of luminal distention oral to the impaction, approximately half of the jejunum immediately oral to the impaction was manually decompressed through the enterotomy site. The enterotomy likely decreased tissue trauma to the small bowel, since decompression was not performed against an edematous ileocecal valve and decompression was only performed once. The ileal impaction was then evacuated using intraluminal lavage with water, similar to the method for lavage via a pelvic flexure enterotomy (6). Lubrication and dissolution of the obstruction were aided by infusion of carboxymethylcellulose and sterile saline using a 60 mL syringe placed into the enterotomy.

The enterotomy site was closed with 3-0 Vicryl in 2 minimally inverting layers using a Cushing's pattern. The bowel was then thoroughly lavaged with sterile saline and replaced within the abdominal cavity. The abdominal cavity was closed in a routine manner with #2 Vicryl for the linea alba, and 2-0 Monocryl for the subcutaneous tissue and skin, using a simple continuous pattern. An iodine-impregnated drape and sterile gauze were applied over the incision. The foal's recovery from anesthesia was uneventful. Total anesthesia time was 2 h and the length of the surgical procedure was 1 h and 40 min.

After the surgery, the filly was maintained on intravenous fluid therapy with Normosol R (Hospira), 66 mL/kg BW per day supplemented with calcium gluconate (MWI Veterinary Supply Co., Meridian, Idaho, USA), 0.43 mg calcium/mL for 72 h. Intravenous antimicrobials were continued (potassium penicillin q6h, gentamicin q24h, for 3 d post-surgery) with the addition of ketoprofen [Ketofen; Fort Dodge (Pfizer)], 2.2 mg/kg BW, IV, q12h for 4 d post-surgery. Heparin (Sagent Pharmaceuticals, Schaumburg, Illinois, USA), 10 000 IU/mL, 25 IU/kg BW, SQ, q6h was added for 48 h for the purpose of adhesion prevention (7). Lidocaine (Vedco Inc.) was administered immediately after surgery (1.3 mg/kg BW, IV bolus, followed by 0.05 mg/kg BW per hour, IV as a constant rate infusion) and continued for 48 h after surgery for its anti-inflammatory properties (8). Twelve hours after surgery, the filly developed slight hypoproteinemia (47 g/L) and hypoalbuminemia (24 g/L), and 3 L of plasma were administered to provide a source of oncotic pressure, anti-thrombin III, and coagulation factors (9).

Additional post-operative management included hourly monitoring for colic, physical examinations, packed cell volume, total solids, peripheral lactate, and glucose levels every 4 h initially, then every 12 h as the filly became more stable. A nasogastric tube was placed post-operatively for gastric decompression; however, at no time did the filly have a positive net volume of reflux. Twelve hours after surgery, the nasogastric tube was removed due to a lack of abdominal discomfort and improvement (increased peristaltic activity and decreased small intestinal diameter) detected by abdominal ultrasonographic examination.

Due to the mare's unwillingness to load on the trailer, the filly had been weaned by the owner at the time of presentation. Twenty-four hours after surgery the filly was offered water and slowly reintroduced to a pelleted diet combined with sweet feed, in a mash (Purina Equine Senior; Purina Mills LLC, Saint Louis, Missouri, USA). Seventy-two hours after surgery, alfalfa hay was slowly added to the feedings until the filly was on a full ration.

Six days after admission, the filly was discharged to the owner with instructions for confinement to a stall for 4 wk, then to a small paddock for 4 wk, and finally pasture turnout if there were no complications with the incision. Recommendations were made to continue feeding alfalfa hay and a pellet formulated for growth. The owners were asked to monitor the filly closely for signs of colic due to the risk of post-operative adhesions or a recurrence of the impaction if she obtained access to coastal Bermuda hay.

One year after the surgery the owner reported that the filly was doing well and had experienced no complications. The abdominal incision healed without event and there have been no episodes of colic since the surgery. The filly's current diet consists of pasture forage, supplemented with free choice access to coastal Bermuda round bales.

Discussion

Ileal impactions account for 12% to 42% of all obstructions affecting the most aboral section of the small intestine (1). Ileal impactions are the inciting cause of colic in horses ranging from 5 mo (10) to 20 y (1,11). To the authors' knowledge, ours is the first report that describes an ileal impaction in an unweaned foal of this age, and the first complete description of this method for small intestinal enterotomy as an option for surgical treatment of an ileal impaction.

Ileal impactions have the greatest prevalence in the southeastern United States, where coastal Bermuda grass hay is the primary source of forage and has been statistically linked to the condition (1,6,12). Coastal Bermuda grass hay is fine, and when harvested in a mature state has a higher lignin content compared with other forages (13). Increased lignin equates to a greater percentage of crude fiber content, which predisposes the patient

to feed impaction (1,14,15). The inherent features of this hay, combined with the type of soil, fertilization, and storage time, all contribute to its digestibility, or lack thereof (16).

A search of our records from 1995 to 2010 showed that weanling foals were rarely admitted for ileal impactions (only 1 found, 5 mo old), and the current case is the youngest foal to survive surgical correction of an ileal impaction. Possible factors that reduce this risk in younger horses may include a diet high in fluid (milk) and an abundance of fresh grass in the spring. Although the coastal Bermuda hay the filly ate was not submitted for nutritional analysis, the presence of a feed impaction at the ileum combined with access to this forage is typical for ileal impactions attributed to this hay and presented to our clinic.

Other causes of ileal impactions include foreign body or ascarid obstruction, tapeworm *(Anoplocephala perfoliata)* infections at the ileocecal junction (1,12), ileal muscular hypertrophy (17), and herniations (abdominal wall, scrotal, or internal) (14). While the absence of a foreign body or body wall hernia definitively ruled out these 2 possibilities, parasites or muscular hypertrophy were considered as possible inciting causes for the ileal impaction in this foal.

Ileal impaction due to tapeworm infestation has been described as a mechanical obstruction due to the attachment of the parasite at the ileocecal valve or due to the formation of granulation tissue at the site of attachment (14). Literature from the United Kingdom (18) and Canada (19) has shown that horses diagnosed with ileal impactions also were more likely to have evidence of tapeworm infestations, but it was not known if the infestation increased the risk of developing colic of any kind (19). Diagnosis of tapeworm infections can be made through flotation of fecal material for tapeworm ova, serologic testing using an enzyme-linked immunosorbent assay (ELISA), or polymerase chain reaction (PCR), with fecal flotation having a lower sensitivity compared with serology (19).

Tapeworms were not definitively ruled out since we did not perform serology, PCR, or fecal flotation and the filly had not been dewormed with pyrantel salts or praziquantal (13,19,20). However, due to the foal's age, it is unlikely that there would have been enough time for the ingestion of a significant number of infected orbatid mites, followed by maturation of the tapeworm to adult status, which typically takes 2 to 4 mo (21). In addition, infestation would have been difficult to prove, since serology has a true positive titer only 56% of the time (19). No gross evidence of tapeworms was noted while lavaging the ingesta from the ileum, but the ileocecal valve was not visualized.

In some equine patients, muscular hypertrophy may be a possible cause of ileal impaction (6). Thickening of the ileum, often inflammatory in origin, leads to narrowing of the intestinal lumen and, in some cases, complete obstruction (12,17,22). In this filly, there was no evidence of thickening of the ileum on palpation of the serosal surface after relief of the impaction, and no signs of inflammatory or cecal disease were noted that would indicate resolution prior to surgical intervention.

Due to the filly's medical history of administration of a piperazine anthelmintic, our leading differential prior to surgery was that of an ascarid *(Parascaris equorum)* impaction. Infection with ascarids is believed to occur in the first few months after birth (23). Gamma-aminobutyric acid (GABA) inhibitors, including piperazine, block the excitatory modulation of small intestinal contractions (24), and rapidly kill the parasites, increasing the risk of obstruction (25). Most cases of ascarid impaction are presented within 24 h of administration of the medication, which fits with the clinical history provided for our case (23,26). Ascarid impactions of the ileum have been described, but no parasites were observed at surgery, ruling out this cause of impaction in our foal (26).

Ileal impactions are often resolved with medical therapy; however, various surgical techniques have been described in the treatment of horses with refractory ileal impactions, including manual extra-mural reduction, enterotomy (described only in combination with resection or bypass), jejuno-ileal anastomosis, and jejunocecostomy (12,27–29). When impaction of the ileum was suspected to be associated with ileal dysfunction, bypass with a jejunocecostomy was performed to prevent re-impaction (1,28). The pathogenesis of these impactions has now been redefined, and the use of this treatment is reserved for cases with evidence of ileal compromise or muscular hypertrophy (1,10,17,30).

Extraluminal massage of the impaction to facilitate passing of the ingesta into the cecum is the surgical treatment of choice for refractory impactions (1). The impaction is broken down by prolonged manual massage with incorporation of fluid ingesta from the jejunum, or by direct injection of saline, dioctyl sodium sulfosuccinate, or carboxymethylcellulose (1,2,6,14). Despite widespread use, the technique seems counter to concerns about tissue handling and predisposes the patient to post-operative ileus and adhesion formation (1,3,6).

Due to the foal's age and length of impaction, there was concern for excessive serosal damage from extraluminal massage of the ileum. In Roussel's study (31), the breed of the horse (Arabian), elevated packed cell volume ($>$ 45%), and a surgical time $>$ 2 h all contributed to the risk of developing post-operative ileus after exploratory celiotomy. In that study, enterotomy (in both large and small intestine) reduced ileus due to reduction of ileal emptying resistance, endotoxin burden, and vascular compression secondary to intraluminal fluid (31). Our opinion was that a jejunal enterotomy would allow for shortened surgical time, gentle luminal decompression, and minimal damage to the foal's small intestine, despite the increased risk of abdominal contamination.

Jejunal and ileal enterotomies were first used out of necessity for small bowel decompression in strangulating lesions (epiploic foramen entrapment), prior to performing a jejunocecostomy, or removal of foreign material (ascarids) (6,29,32). Treatment of ileal impactions using enterotomy has been briefly mentioned in the literature, but the descriptions are incomplete (2,10,29,30,32,33). The survival rates for this technique were poor, but it is difficult to compare the old reports to surgeries performed today, due to advances in surgical and nursing techniques (10,30).

Our approach involved a longitudinal incision along the antimesenteric border of the bowel. Decompression of the aboral small intestine was accomplished with minimal serosal trauma

due to minimal resistance at the enterotomy site. Breakdown of the ileal impaction was facilitated by lubrication with intraluminal administration of carboxymethylcellulose and sterile saline into the impaction and prevented excessive distention of the cecum. Trauma to the ileum caused by the stripping process was reduced by rapid resolution of the impaction. The two-layer Cushing's pattern for closure of the enterotomy was selected to reduce the risk of adhesions and provide increased security for the closure (34–36). There was minimal concern for stricture, due to the linear nature of the incision, and careful attention to minimally invert the tissue.

Surgery is indicated for impactions that do not respond to medical therapy or cases in which surgical lesions cannot be ruled out. Complications associated with surgical treatment include post-operative ileus, gastric rupture, and laminitis (6,37). Concerns with small intestinal enterotomies include adhesions, narrowing of the small intestinal lumen, and kinking of the small intestine at the site of enterotomy (6). Ileotomy or distal jejunotomy has also been related to a decrease in return of normal peristalsis due to excessive trauma and/or contamination of the affected area which would ultimately contribute to re-impaction at the site (10).

This paper is the first to describe the successful surgical treatment of an ileal impaction using an enterotomy in a nursing foal. By performing a jejunal enterotomy, there was a reduction of tissue trauma with quick resolution of the extensive impaction, which may have contributed to the lack of post-operative complications. There was aggressive post-operative monitoring and management with lidocaine and heparin and the foal recovered from surgery without complication. CVJ

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