Small intestinal strangulation caused by a mesodiverticular band and diverticulum on the mesenteric border of the small intestine in a horse

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Abstract — A 4-year-old Quarter horse stallion was presented for acute abdominal pain. Exploratory celiotomy revealed a mesenteric diverticulum of the jejunum and mesodiverticular band that were associated with small intestinal strangulation. Resection and anastomosis were performed. A second celiotomy was performed due to adhesions. The horse recovered completely and returned to training.

Résumé — Strangulation du petit intestin causée par une bande mésodiverticulaire et un diverticule à la frontière mésentérique du petit intestin chez un cheval. Un étalon Quarter horse âgé de 4 ans a été présenté pour une douleur abdominale aiguë. Une laparatomie exploratoire a révélé un diverticule mésentérique du jéjunum et une bande mésodiverticulaire qui ont été associées à une strangulation du petit intestin. La résection et l’anastomose ont été réalisées. Une deuxième laparatomie a été réalisée en raison des adhérences. Le cheval s’est complètement rétabli et est retourné à l’entraînement.

(A traduit par Isabelle Vallières)

A small intestinal diverticulum in the horse is a rare cause of abdominal pain (1). When present, diverticula are commonly diagnosed as an incidental finding at necropsy or on exploratory celiotomy (1). They are generally located in the antimesenteric border (Meckel’s diverticulum) and less frequently in the mesenteric border of the jejunum and ileum (2–4). Mesodiverticular bands are congenital anomalies that can cause small intestinal obstructions, generally associated with Meckel’s diverticulum (4). This case report describes the clinical manifestation, treatment, and outcome of a mesenteric diverticulum on the jejunum with an associated antimesenteric mesodiverticular band, which resulted in strangulation of small intestine.

Case description

A 4-year-old 475-kg Quarter horse stallion was referred to The Ohio State University Galbreath Equine Center on emergency for evaluation of acute signs of abdominal pain. Prior to presentation, the horse was administered mineral oil (half-gallon by nasogastric tube), intravenous flunixin meglumine (Banamine; Schering-Plough Animal Health, Union, New Jersey, USA), 750 mg and intravenous xylazine hydrochloride (Anased, Lloyd Laboratories, Shenandoah, Iowa, USA), 150 mg by the referring veterinarian. The horse had been vaccinated and dewormed on a regular basis and had no history of abdominal pain during the preceding 4 y.

On admission, the horse showed severe signs of abdominal pain and was treated with 200 mg of xylazine hydrochloride intravenously for analgesia. Physical examination after sedation revealed that the heart rate (80 beats/min), respiratory rate (32 breaths/min), and rectal temperature (39.1°C) were all elevated. Mucous membranes were dry and hyperemic and the capillary refill time was > 3 s. Borborygmis were absent in all quadrants on abdominal auscultation. Multiple loops of distended small intestine were palpated during rectal examination. Transabdominal ultrasound with a 2.5-MHz curvilinear transducer revealed several thickened, amotile loops of distended small intestine localized in the caudoventral abdomen. No gastric reflux was obtained on nasogastric intubation. Abdominocentesis was not performed due to the horse’s disposition while being examined.

Complete blood (cell) count (CBC) results were all within reference ranges. The packed cell volume (PCV) was 47% [reference range (RR): 32% to 44%], serum total protein concentration (TP) was 71 g/L (RR: 65 to 78 g/L), and blood lactate concentration was 0.21 mmol/L (normal < 0.22 mmol/L). No serum chemistry was performed; however, a serum electrolytes sample was obtained and values were within the normal reference range.

Due to the physical examination findings, moderate to severe signs of colic, and the lack of response to medical management, an exploratory celiotomy under general anesthesia was...
recommended. Potassium penicillin G (Pfizerpen; Pfizer, New York, New York, USA), 22,000 U/kg body weight (BW), IV, q6h, gentamicin sulfate (Gentaved; VedCo, St. Joseph, Missouri, USA), 6.6 mg/kg BW, IV, q24h, and flunixin meglumine (Schering-Plough Animal Health), 1.1 mg/kg BW, IV, q12h were administered preoperatively. The horse was premedicated with xylazine hydrochloride (Lloyd laboratories), 0.5 mg/kg, BW, IV and induced with a combination of diazepam (Cardinal Health, Dublin, Ohio, USA), 0.1 mg/kg, BW, IV, and ketamine hydrochloride (Ketaset; Lloyd Laboratories), 2.2 mg/kg BW, IV. Anesthesia was maintained with isofluorane.

The horse was placed in dorsal recumbency and draped in an aseptic manner. A 30-cm ventral midline incision was made along the linea alba. Exploratory celiotomy revealed strangulation of the proximal ileum and distal jejunum (approximately 3 to 4 m) that was incarcerated inside a blind sac (Figure 1). The sac was located approximately 4 m orad to the ileum, and consisted of a mesodiverticular band extending from the mesenteric border to the antimesenteric border of the jejunum and a 20 cm² diverticulum communicating with the mesenteric border of the jejunum (Figure 2).

Due to the incarceration and a segmental volvulus, the small intestine inside this sac was strangulated and deemed nonviable based on the black-purple coloration of the serosa, increased intestinal wall thickness, edema, and lack of motility. The surgical lesion was identified and corrected. Approximately 5 m of small intestine (including the ileum, distal jejunum, and the jejunal diverticulum) were resected and a side-to-side jejunoocecostomy was performed. Sodium carboxymethylcellulose was used during bowel manipulation. Affected small intestine was isolated from the abdomen with saline-soaked laparotomy sponges. The mesenteric vessels were ligated with size 2-0 glycolide/lactide copolymer (Polysorb; Ethicon, Somerville, New Jersey, USA) or via use of the LigaSure device (Covidien, Boulder, Colorado, USA). Small intestinal contents aboral to the strangulation were decompressed by stripping the contents through an enterotomy in the strangulated segment. No significant distention was noted in the small intestine oral to the strangulation.

The cecum was exteriorized and the apex retracted caudal to expose the dorsal band of the cecum. The ileum was exteriorized, resected proximal to the ileocecal junction using a TA90 stapler (Auto Suture, United States Surgical Corporation, Norwalk, Connecticut, USA), and the staple line of the ileal stump was oversewn with 2-0 glycolide/lactide copolymer in a continuous Lembert pattern. The ileal stump did not seem to be edematous, devitalized, or necrotic. The jejunum, including the diverticulum, was then resected using a 2-clamp technique and incised using a number 10 scalpel blade, removing the remaining portion of compromised jejunum. The remaining end of the jejunum was hand sutured with a Parker-Kerr over-sew pattern, and the entire length of jejunum re-examined to ensure that it was not twisted or rotated.

The jejunal stump and the cecum were brought into apposition, and the jejunum was anastomosed to the cecum between the dorsal and medial bands, in close proximity to the ileocecal orifice. The antimesenteric border of the distal end of the jejunum was sutured to the cecum using size 2-0 glycolide/lactide copolymer in a simple continuous pattern. Stab incisions were made into the jejunum and the cecum, a GIA 80 staple line reinforcement (United States Surgical Corporation) was inserted into the incisions, creating the stoma of the anastomosis. The stoma created was approximately 8 cm in length. The GIA was removed and the holes were closed with a continuous Lembert pattern. The line of staples of the anastomosis was oversewn with 2-0 glycolide/lactide copolymer in a continuous Cushing pattern. Jejunal mesentery was sutured to the ileal stump, ileocecal fold, and dorsal band of the cecum with a simple continuous suture pattern using size 2-0 glycolide/lactide copolymer.

Abdominal lavage with sterile physiologic saline was performed prior to closure. The linea alba was closed in routine fashion with size 3 polyglactin 910 (Vicryl, Ethicon) in a simple

Figure 1. Photograph illustrating the blind sac created by a space bordered by the jejunum, intestinal mesentery, and the mesodiverticular band (being stretched between thumbs). The jejunum and proximal ileum were entrapped in this sac.

Figure 2. Photograph showing the diverticulum on the mesenteric border of the jejunum and the attachment of the transected antimesenteric mesodiverticular band (manually isolated).
following surgery, antimicrobial treatment was continued for 72 h, and flunixin meglumine was administered for 48 h, at intervals previously noted. Intravenous fluid therapy (lactated ringers solution with calcium) was provided at maintenance rates for 16 h after surgery. The horse was allowed access to water within 12 h after surgery. The horse started to pass manure approximately 12 h after surgery. Short periods of grazing or small amounts of grass were offered within 12 h of the surgery. The amount of feed was gradually increased. Four days following surgery, the horse was receiving 1 flake (1.5 kg) of hay every 4 h and all medications were discontinued.

During the hospitalization there were no post-operative complications. The horse was discharged from the hospital at day 10, and the owner was instructed to gradually reintroduce a normal diet.

Histopathology results showed gross demarcation of normal to strangulated tissue, containing mild to marked submucosal edema, focal fibrinoid vascular necrosis, thrombosis, and hemorrhage, as well as necrosis/loss of mucosal villi and petechiation of the muscular wall due to venous infarction. The lumen of the diverticulum communicated with the jejunum and contained a small amount of ingesta. Macroscopically, the mucosal surface of the diverticulum was similar to the mucosal surface of the jejunum.

At 20 days following the exploratory celiotomy, the horse was again presented to the emergency service with signs of acute abdominal pain, including inappetence and lethargy. His heart rate (32 beats per min), respiratory rate (24 breaths per min), and rectal temperature (37.4 °C) were all within normal limits. Rectal palpation revealed marked distention of the small intestine. Transabdominal ultrasound with a 2.5-MHz curvilinear transducer revealed several thickened, amotile loops of distended small intestine that were localized in the right and left caudoventral abdomen. No gastric reflux was obtained on nasogastric intubation. Complete blood (cell) count results were within the reference range. The packed cell volume (PCV) was 30% (RR: 32% to 44%) and serum total protein concentration (TP) was 69 g/L (RR: 65 to 78 g/L). Serum chemistry revealed an elevated creatinine of 176.8 μmol/L (RR: 70.7 to 176.8 μmol/L), with all other parameters within the reference range.

Medical treatment consisted of IV polyionic fluids (1.5 L/h), flunixin meglumine (1.1 mg/kg BW, IV, q12h), and xylazine hydrochloride (1.1 mg/kg, IV). Despite medical management, signs of abdominal pain became severe and surgical exploration of the abdomen was carried out. Pre-operative medication and anaesthesia protocol was the same as in the previous surgery. A ventral midline celiotomy through the previous incision was performed under general anesthesia. On exploration of the abdomen, significant fibrinous adhesions were identified between the tip of the cecum and ventral edge of the spleen and the right ventral body wall. Each adhesion was isolated and manually broken down.

During the exploration of the abdomen, the cecum could not be completely exteriorized. Numerous adhesions were palpated between the body of the cecum and the right lateral body wall. The adhesions were resected blindly inside the abdomen using a GIA 80. Adhesions also involved part of the mid-jejunum causing a mechanical obstruction. Each adhesion was isolated and manually broken down. Once the cecum was exteriorized, the small intestine could be examined fully. Moderate gas distention with a small amount of fluid was identified throughout the distal half of the remaining small intestine. The small intestine was manually decompressed through the anastomosis site and into the cecum. No abnormalities were noted at the anastomosis site. The length of the stoma remained approximately 8 cm. Sodium carboxymethylcellulose was used during bowel manipulation. Adhesions between the small intestinal mesentery and the ileal stumps were palpatel but not visualized at the level of the root of the mesentery. These adhesions did not seem to cause any mechanical or obstructive problem to the remaining small intestine and its mesentery. Hyaluronic acid (Legend; Bayer Animal Health, Shawnee Mission, Kansas, USA) was placed topically (1 mL) in 3 to 4 areas of the cecum where the adhesions were resected. The horse recovered uneventfully from anesthesia.

Five days post-operatively, the horse had a rectal temperature of 39.2°C. Ultrasonographic evaluation of the thorax, abdomen, and surgical incision was performed. A small fluid pocket at the caudal end of the incision was noted, and drained via removal of surgical staples. The fluid sample was submitted for culture and sensitivity, indicating the presence of methicillin resistant Staphylococcus aureus and Escherichia coli. The infected surgical site was cleaned daily with 0.07% chlorhexidine diluted with sterile saline. No other post-operative complications were observed during the remainder of the hospitalization.

At the time of follow-up, 18 mo after the first surgery, the horse had returned to the previous level of work. No further signs of abdominal discomfort had been observed by the owner, trainer, or veterinarian.

Discussion

In this case, a diverticulum in the mesenteric border of the jejunum associated with a mesodiverticular band was a rare cause of acute colic in an adult horse. As shown in Figure 2, the antimesenteric attachment of the mesodiverticular band was in close relation with the antimesenteric side of the diverticulum. The volvulus and strangulation of the small intestine were directly associated with the diverticulum and the mesodiverticular band.

In horses, Meckel’s diverticula and mesodiverticular bands are the most common types of congenital abnormalities that affect the small intestine (1). Other abnormalities such as small intestinal diverticulosis have been reported at different segments of the small intestine, such as the mesenteric border of the ileum (5), antimesenteric border of the jejunum (6), or antimesenteric border of the ileum. Most cases of small intestinal diverticulosis reported in the literature have been presented with acute or chronic abdominal pain or both, associated with small intestinal perforation or obstruction (2,3,7). In the 2 cases of jejunal diverticulosis with perforation and resulting peritonitis (2), diverticula were associated with muscular hypertrophy and eosinophilic enteritis. Reported cases of small intestinal
diverticula in horses have been associated with a poor outcome. In most cases, the animals were euthanized because of economic constraints and guarded prognosis (2–4,7,8).

The pathogenesis of small intestinal diverticula in horses is unknown, but has been postulated to be similar to that of human cases. In both horses and humans, herniation of jejunal mucosa through a defect in the muscularis layer has been termed false pulsion diverticulum. In horses, diverticula are often associated with idiopathic muscular hypertrophy (9), compared with humans, where muscular hypertrophy is rare. In humans, jejunal diverticula occur as herniations of mucosa through the submucosa and muscularis on the mesenteric side of the intestine at the points of entrance of the blood vessels (10). However, the prevalence of diverticula in humans along the mesenteric border of the small intestine is very low, and they are most often incidental findings at autopsy or associated with malabsorption, intestinal hemorrhage, mesenteric absceses, or intestinal obstruction (11–13). In the case we report, no muscular hypertrophy or eosinophils were detected on histopathology, rather evidence of infarction and vascular compromise was present. Macroscopically, the lumen of the diverticulum communicated with the small intestine, and the mucosal surface was similar to the rest of the small intestine.

Strangulation and volvulus of the small intestine secondary to mesodiverticular bands have been reported in horses (4). Bands arise from the cranial mesenteric artery or along the mesenteric vein, and extend to the antimesenteric intestinal border, or to a diverticulum, if present. Histologically, mesodiverticular bands have collagen and fibroblast patterns suggestive of persistent vitelline artery tissue, from which they arose. In reported cases, small intestine becomes incarcerated within a space bordered on each side by the intestinal segment (ileum or jejunum), intestinal mesentery, and the mesodivertricular band. Treatment in these instances is via surgical intervention with exploratory celiotomy and resection of the affected bowel segment. Volvulus of the small intestine usually occurs secondary to shortening of the mesentery, resulting from attachment of the band (4). It is recommended that both the mesodiverticular band and the affected small intestinal segment be resected to prevent further volvulus and subsequent strangulation (4,14).

The need for a repeat celiotomy has been well-documented in association with small intestinal diseases (14). Furthermore, repeat celiotomies have been performed more often following jejunoccecostomies, rather than jejunoejejunosotomies (14). In this case, despite all of the precautions taken during the first surgery and the use of sodium carboxymethylcellulose, intestinal adhesions causing a mechanical obstruction were found at the second celiotomy. Intestinal adhesions are a common complication reported in horses undergoing exploratory celiotomy for small intestinal lesions, and may be associated with small intestinal obstructions or chronic episodes of abdominal pain in horses (14,15). The location and intestinal segments involved with the adhesions can determine if they remain clinically “silent” or cause complications (16). In this case, multiple bowel segments had adhesions causing obstruction; however, none were associated with the anastomosis site.

Repeat celiotomy has also been identified as a predisposing factor for incisional infections. The frequency of infections can be 3 times higher in horses with 2 or more celiotomies (17). In this case, despite the isolation of methicillin resistant Staphylococcus aureus from the incisional site, the horse recovered without any further complications.

In this unique case, a diverticulum in the mesenteric border of the jejunum associated with a mesodiverticular band resulted in a rare cause of acute colic in an adult horse. These anomalies likely occurred during embryonic or fetal development, but did not cause any clinical signs until the small intestine became entrapped in the blind sac. Therefore, if a diverticulum and a mesodiverticular band are discovered during an exploratory celiotomy for reasons other than strangulation, one should consider resection and anastomosis of the diverticulum and surrounding jejunum to prevent strangulation in the future. However, once strangulation occurs, prompt surgical treatment with resection and anastomosis of strangulated bowel can result in a favorable outcome, as was noted in this case.

Acknowledgment
Dr. Ernst saw the case on emergency while employed at the Ohio State University. His current address is the University of Minnesota.

References