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Abdominal pain in the foal can originate from a multitude of problems, and presents a diagnostic challenge. Foals typically have a low pain threshold compared to adults, and this compounds the difficulty in assessment of the gravity of the colic signs. As with all colics, an important goal of the evaluation process is to assess the potential need for surgical intervention and avoid delays that will compromise the outcome. However, unlike exploratory laparotomy in adults, unnecessary surgical intervention carries a great risk of both short and long term complications that makes the accuracy of the diagnosis and the decision for surgery especially important.

A variety of sources of information as part of the signalment and history should be used in the evaluation process. The age of the foal at the onset of clinical signs and at presentation can be very helpful in creating a list of differential diagnoses. Foals with congenital disorders of the gastrointestinal tract usually show signs of colic pain within hours of foaling. These problems include atresia coli, aganglionosis, and hypoganglionosis and are fortunately rare in all breeds. A much more common source of abdominal pain is meconium impaction, which generally results in clinical signs within the first 1-2 days of life. Colic pain is meconium impaction is generally much milder than colic associated with the gastrointestinal tract, and is usually seen between 2 and 5 days after birth. Finally, breed predilections for certain conditions such as fecoliths in miniature horses may be helpful in decreasing the list of possible differential diagnoses.

In addition to the signalment of the patient, an accurate history will often give important information regarding the source of pain. The presence of diarrhea or fevers in other foals on the farm may suggest that the pain is related to enteritis rather than a mechanical source of pain. Administration of antibiotics for other problems such as respiratory problems or flexural limb deformities may produce alterations in normal gut flora that could result in colic pain, as can changes in the nutritional management of the mare or the foal.

A detailed and systematic clinical evaluation of the colicky foal is essential, with the main goal of the exam being the determination of the existence of a surgical or non-surgical lesion. Physiologically, neonatal foals do not manage the systemic compromise and cardiovascular shock associated with strangulating lesions nearly as effectively as adults, so rapid determination and correction of these types of problems is vital to a successful outcome. Observation of the foal from outside the stall is an important part of the physical exam if the colic signs are not too severe to allow it. Foals that are restrained may not demonstrate the true character of their pain, and observation from a distance may suggest other problems such as white muscle disease, botulism, neurological disorders, or even simple irritation of the skin from with excessive iodine disinfection of the navel. Documentation of appetite, quality of suckle, ability to swallow, muscle tremors or lameness, and other gait abnormalities can best be observed with minimal restraint of the mare and foal.

Typical colic pain in the foal is exhibited in patterns similar to those seen in adults and most often includes rolling up into dorsal recumbency, straining to defecate or urinate, and dropping rapidly from a standing position to ventral or lateral recumbency. However, the severity of these signs often correlates poorly with the severity of the lesion because of the foal’s intolerance of abdominal pain compared to adults. Rolling into dorsal recumbency and bruxism are often associated with gastric ulceration, but are also commonly seen with volvulus and intussusception of the small intestine. In general, pain that is severe and unremitting and responds poorly or for a very short duration to analgesics is consistent with a surgical lesion. Mild pain that progresses to severe colic signs frequently indicates medical problems like enteritis, ulcers, or simple obstruction of the large intestine.

Physical examination of the foal is often unrewarding in the effort to differentiate between surgical and non-surgical problems. Deterioration in mucus membrane color and elevated heart rate is consistent with endotoxemia, septicemia, strangulation, enteritis, and peritonitis. However, severe toxic changes in mucus membrane color and heart rates greater than 120 beats/minute generally suggest a surgical lesion. Abdominal auscultation is non-specific both for severity and anatomic source of pain, but is useful for sequential evaluation of signs in the determination of surgical vs. non-surgical problems.

Peritoneal fluid analysis is a highly useful tool in evaluation of the colicky foal. Enteritis and simple obstructions like meconium impaction usually cause no change in the peritoneal fluid initially, but over time may lead to moderate elevations in cell count and total protein concentration. Strangulating obstruction, on the other hand, produces rapid changes in the physical appearance and laboratory parameters of peritoneal fluid and this can be a strong indicator for surgery. Abdominal paracentesis in the foal should always be performed with a blunt teat cannula and not a needle, as is often done in the adult, due to the fragility of the intestine and the ease of puncturing the bowel, and can easily be performed in lateral recumbency if necessary.

Nasogastric intubation can be helpful from both a diagnostic and therapeutic perspective, with large volumes and/or continual production of reflux suggestive of severe small intestinal obstruction caused by volvulus, intussusception, or upper small intestinal strictures. Nasogastric intubation in older foals may produce ascarids, suggesting SI ascarid impaction.

While rectal examination gives limited information in the foal compared to the adult, abdominal radiography is an extremely useful tool in evaluation of the neonatal abdomen. Good quality radiographs of foals up to 500 pounds can be obtained with standard equipment used in ambulatory radiography that have mAs capability in the 10-20 range and kVp in the 75-95 range. Gas distention of the small intestine is seen as multiple intra-luminal gas/fluid interfaces, and is associated with enteritis, peritonitis, and small intestinal obstruction. In meconium impactions or large intestinal displacements and volvulus the large colon is distended and may be displaced. Barium enemas delivered by gravity can be diagnostic for meconium impaction in the small colon, and barium administered by nasogastric tube can identify pyloric or duodenal strictures.

Finally, abdominal ultrasonography is a very useful tool in evaluation of the foal’s abdomen. Ultrasound equipment typically used for reproductive work (5.0 MHz linear probe) generally gives adequate images, and can identify changes...
in small intestinal motility, distention, and wall thickness.
Small intestinal intussusception can appear as a doughnut shaped image, and rounded and enlarged loops are characteristic of enteritis or obstruction. Gas filled large intestine produces a reflection of the sound waves and results in a poor image of the abdomen. Abdominal fluid can also be seen with ultrasound, and amount and echogenicity of the fluid can provide useful information on the differential causes of colic pain.

SPECIFIC CONDITIONS PRODUCING ABDOMINAL PAIN IN FOALS

Meconium impaction

Meconium impaction is probably the most common cause of colic pain in the foal. Normal passage of meconium begins shortly after birth and continues for the first 24-48 hours of life. Pain associated with this condition varies from mild to severe, and the location of the retention can include the rectum, small colon, transverse colon and large colon. Useful diagnostic tools include digital rectal examination, abdominal radiography and barium enemas. Medical treatment is generally successful, and surgery should be avoided unless pain is uncontrollable or serial peritoneal fluid evaluations show evidence of bowel inflammation. Meconium impactions may be preventable by administration of 1-2 phosphate enemas within the first 12 hours after foaling. Once identified, warm soapy water enemas administered by gravity feed using a very soft Nasogastric tube is often successful in conjunction with judicious use of intravenous fluids. Enemas with acetylcysteine are even more effective in breaking up the impaction. Liquid acetylcysteine is available commercially as a 20% solution, and can be mixed with 160 ml of water to obtain a 4% solution. Because the activity of acetylcysteine increases with increasing pH, 20 g of NaHCO3 powder (commercial baking soda) to the 200 ml of diluted solution. Alternatively, a 4% solution with pH 7.6 can be economically prepared with 8 g powdered acetylcysteine mixed with 20 g NaHCO3 and 200 ml water. For the procedure, foals are generally sedated with xylazine (0.3-0.5 mg/kg, i.v.) or diazepam (0.2-0.4 mg/kg, i.v.) and restrained in lateral recumbency. A 30 Fr. Foley catheter with a 30 ml bulb is inserted 2.5-5 cm into the rectum and the balloon is gently inflated until the anus and rectum are occluded. One hundred to 200 ml of 4% acetylcysteine is then administered by gravity feed, and retained for 30-45 minutes. Foals are given intravenous fluids concurrently, and pain and straining are managed with additional doses of xylazine, diazepam, or butorphanol (0.01 mg/kg, i.v.). The procedure can be repeated up to 3 times at 12 to 24 hour intervals. A recent retrospective study from the University of California-Davis showed that this treatment protocol was highly successful in achieving a favorable outcome without surgical intervention, and using this technique virtually eliminates the need for surgery in management of this condition. Enemas in foals should always be performed with caution, as penetration of the small colon with the enema tube or rupture of the intestine secondary to overdistention can occur.

Enterocolitis

Diarrhea has been reported in up to 80% of foals, and is often seen during the first month of life. Pain associated with enterocolitis is usually less severe than that seen in surgical diseases, and is usually present prior to the presence of diarrhea. Enterocolitis in foals can be associated with milk overload, “foal heat” diarrhea, Rotavirus infection, or Clostridium and Salmonella infection. Diagnosis is based on farm history, physical and laboratory evaluation of the foal, and response to antibiotic therapy. Fecal cultures, virus isolation, and Rotavirus identification tests are useful diagnostic tools. Treatment is usually medical, and includes fluid replacement, electrolyte and bicarbonate supplementation, and antibiotics. Necrotizing enterocolitis associated with Clostridium perfringens type C and Clostridium difficile is a serious and under-diagnosed cause of gastrointestinal dysfunction and colic pain in foals, and should be suspected in any foal that is having difficulty tolerating oral feeding, has ileus, intermittent episodes of colic pain, or who has occult or frank blood in the feces. Oral feeding should be avoided if possible and nutrition supplied by parenteral feeding, and broad spectrum intravenous antibiotics and metronidazole (25 mg/kg, p.o., b.i.d.) are indicated. Gastric ulceration is also a common sequelae to enterocolitis, and can be managed with ranitidine (6.6 mg/kg, i.v., q4h) or with omeprazole (4 mg/kg, p.o., s.i.d) and sucralfate (10-20 mg/kg, p.o., t.i.d to q.i.d) if there is some evidence of progressive upper GI motility.

Herniation

Abdominal hernias can be external or internal, and can produce colic signs by strangulation of intestine or by simple obstruction of the herniated viscus. Inguinal and umbilical hernias are the most common external hernias, and diaphragmatic hernia is the most common internal hernia. Herniation is made through physical examination, abdominal radiography, and abdominal/thoracic paracentesis. External herniation can be managed conservatively by physical reduction of the hernia either manually or with bandages, but surgical intervention is usually indicated when colic signs are present. Diaphragmatic hernias can be caused by blunt trauma, but are usually secondary to laceration of the diaphragm secondary to rib fractures incurred during parturition.

Uroperitoneum

Ruptured bladder or ruptured urachus are the most common causes of uroperitoneum, but ruptured ureter(s) should also be in the list of differentials. Colic pain is usually mild and is associated with abdominal distention. Clinical signs are more commonly associated with electrolyte abnormalities, uremic encephalopathy, and manifest primarily as depression and a fluctuant abdominal distention. Diagnosis is made by abdominal ultrasound showing large volumes of anechoic peritoneal fluid, and confirmed by comparison of serum and peritoneal fluid electrolyte and creatinine values. Correction requires surgical intervention, but medical management should often precede surgery to at least partially correct laboratory parameters that put the foal in excessive anesthetic risk. A more detailed discussion can be found in these proceedings notes entitled “Management of Disorders of the Urinary System in the Equine Neonate.”

Small Intestinal Volvulus

Volvulus of the small intestine is a relatively common cause of surgical colic in foals. Affected foals are typically very painful, respond poorly to analgesics, have abnormal peritoneal fluid, and are in varying stages of cardiovascular collapse. Abdominal radiography and ultrasound will show
multiple loops of distended small intestine. Gastric reflux is usually present. Treatment requires surgical intervention, usually with resection and anastomosis of the affected portion of intestine. However, some cases with rapid access to surgery from the time of first pain or when the strangulation is not tight can be managed without resection of the involved intestine.

**Gastric Outflow Obstruction**

This condition can result from either functional or mechanical problems in the stomach, pylorus, or duodenum, and is usually secondary to ulceration of the above structures. Inflammation associated with ulcers is believed to interfere with gastric contraction and emptying, and over time can result in cicatrix formation that produces a mechanical obstruction. Diagnosis is based on clinical signs of gastric ulcers (bruxism, playalisis, and relief of pain in dorsal recumbency) along with endoscopic evaluation and contrast radiography using barium delivered to the stomach by nasogastric intubation. Contrast agent should take no longer than 30-45 minutes to leave the stomach in normal foals. Most gastric ulcers can be managed medically with H2 blockers, proton pump inhibitors, and protective agents that coat the stomach. These agents include ranitidine (6.6 mg/kg, i.v. q4h, or 5-10 mg/kg, p.o., b.i.d. to q.i.d.), omeprazole (4 mg/kg, p.o., s.i.d.) and sucralfate (10-20 mg/kg, p.o., t.i.d. to q.i.d.). Mechanical obstruction requires surgical intervention, and strictures are usually seen or palpated at the pylorus or along the duodenum. A gastroduodenostomy or gastrojejunostomy is used to bypass pyloric obstructions, and a gastrojejunostomy is performed to bypass duodenal obstructions. Intestinal stapling equipment is very useful for these procedures, which are difficult to perform due to poor visibility, limited available space for manipulations, and difficulty avoiding contamination of the peritoneal cavity.

**ADDITIONAL CAUSES OF ABDOMINAL PAIN REQUIRING SURGICAL INTERVENTION**

Intussusceptions, large colon volvulus, large colon displacements, and small intestinal impactions are occasionally seen in foals, but are, with the exception of intussusceptions and small intestinal impactions, less frequently encountered in young horses than adults. For the most part, diagnostic procedures are non-specific, but should identify the patient as a surgical candidate based on persistence of abdominal pain, peritoneal fluid analysis and alterations identified with radiographs and abdominal ultrasound. Small intestinal impactions are frequently caused by ascarids, and parasite loads in the small intestine can be identified by ultrasound or the presence of worms in the gastric reflux.

**GENERAL PRINCIPLES OF ABDOMINAL SURGERY IN THE FOAL**

Ideally, foals about to undergo abdominal surgery should be in the best possible physical condition, which can be facilitated with the appropriate use of intravenous fluids, administration of electrolytes, and balancing acid base status. However, judgment must be used in determining the relative benefits of these pre-operative treatments with the delays involved during diagnosis and administration of medications prior to surgery. Broad spectrum antibiotics such as amikacin sulfate (25-30 mg/kg, i.v., s.i.d.) or gentamicin sulfate (8.8 mg/kg, i.v., s.i.d.) combined with potassium penicillin (20,000-50,000 U/kg, i.v., q.i.d.) or sodium ampicillin (50-100 mg/kg, i.v., q.i.d.) are commonly used prior to surgery. In addition, flunixin meglamine (0.25-1.1 mg/kg, i.v., s.i.d. to b.i.d. high dose or q.i.d. low dose) should be given presurgically regardless of the presumed diagnosis, and a nasogastric tube placed prior to induction. In neonates, anesthesia can be induced by masking the foal with isoflurane or by inducing with diazepam and ketamine. Direct arterial blood pressure is recommended in the anesthetic management of the colicky foal. The goal of surgery is to quickly correct the lesion, concentrating on minimizing trauma to decrease the risk of adhesions. This is accomplished by using aseptic technique, rinsing powder from surgical gloves, initiating and maintaining appropriate antibiotic and anti-inflammatory medications, copious lavage of the intestines with saline or lactated ringer’s solution, and keeping the intestine in the abdomen as much as possible. Omentum is frequently resected, and carboxymethylcellulose and sodium hyaluronan have been used topically to reduce the risk of adhesion formation. Closure of abdominal incisions is similar to adults, but foals can be turned out as early as three weeks in cases with uncomplicated recoveries.