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Abdominal Ultrasonography in the Equine Patient With Acute Signs of Colic

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1. Introduction
Abdominal pain in horses is one of the most common presenting clinical signs and a major cause of mortality in horses. Rapid and effective evaluation of horses with signs of colic is necessary for prompt surgical intervention, thereby allowing for more successful outcomes. However, determining the actual cause of colic in horses is a diagnostic challenge, and the decision for selecting abdominal surgery in horses with colic is not always straightforward. Analgesic administration or stoic horses may delay necessary abdominal surgery, resulting in a decreased prognosis for survival.

The decision between medical management and surgical intervention is largely made on the basis of physical examination, abdominocentesis, abdominal palpation per rectum and, most importantly, persistent signs of abdominal pain despite medical treatment. More recently, abdominal radiography and abdominal ultrasonography have become more useful in evaluating horses with abdominal pain. Several recent studies have shown that abdominal ultrasonography in the colic patient can be a very useful diagnostic tool.

Technique
Abdominal ultrasonography is a very safe and non-invasive diagnostic test. After initial examination of a horse with signs of abdominal pain, the baseline pain level should be considered. An abdominal ultrasound examination should not be performed if a horse has fractious behavior or is showing signs of uncontrollable abdominal pain despite sedation.

The abdominal wall is saturated with isopropyl alcohol using a spray bottle to dampen the hair and create adequate contact with the transducer to achieve adequate image quality. Ultrasonographic coupling gel can then be applied liberally to the ultrasound transducer to further enhance the image quality. A 3.5-MHz convex linear transducer with a maximal depth range of at least 25 cm is used for ultrasonographic examination of the equine abdomen. To evaluate the deeper areas of the equine abdomen, the focal zones should be positioned in the far field to enhance visualization of deeper structures. In most ambulatory settings, a practitioner may not have a 3.5-MHz probe available. A 5-MHz linear rectal probe may be used instead but will give the examiner a much smaller ultrasonographic window of the abdomen. The 5-MHz probe does not provide the same level of penetration as a 3.5-MHz convex linear transducer, but it is adequate to evaluate portions of the equine adult abdomen for signs of abdominal pain.

A systematic approach to each ultrasound examination in a horse for signs of colic is recommended.
The abdomen is divided into three regions (right paralumbar fossa [PLF] region, ventral region/inguinal region, and left paralumbar fossa). Each region can be further subdivided into right PLF 1, 2, and 3; ventral (V) 1, 2, and 3; and left PLF 1, 2, and 3. The examination should start in the right paralumbar fossa and continue to the ventral/inguinal region and then the left paralumbar fossa region after the horse is turned around or the machine moved to the other side of the horse. The right and left intercostal regions should also be evaluated for possible intestinal abnormalities. The margins of these regions are meant to serve as a guideline for a systemic ultrasound examination. In most equine cases with colic, an individual region does not correspond with a specific diagnosis for the signs of colic.

Abdominal Ultrasound of the Normal Horse

In clinically normal horses without signs of abdominal pain, the large intestine can be distinguished from the small intestine by size and appearance. The large colon can be visualized in all three regions and appears as a bright hyperechoic line correlating with the ventral colon sacculations or the wall of the dorsal colon (Fig. 1). Because of the size of the large colon and the presence of gas and feed within the colon, the deep border is often not visualized and the colon cannot be imaged as a complete loop. In a normal horse, individual layers of the colon are not typically visible.

Transverse sections of the small intestine are imaged as complete loops, and usually more than 1 loop can be viewed (Fig. 2, A and B). In a normal horse, the small intestine can be imaged as circular densities that show continuous movement. The small intestine is often visible along the ventral axial surface of the spleen from the left side and in the inguinal regions. Small intestine wall thickness in clinically normal horses is difficult to measure when scanning at maximal depth because it is less than the width of the measuring cursors (<3 mm). It is very rare to visualize distended loops of small intestine in a clinically normal horse.

The nephro-splenic space is imaged in the left PLF 1 region, where the left kidney and caudal edge of the spleen are consistently identified (Fig. 3). The stomach wall should be visualized in the left intercostal spaces, but the stomach should not be distended with fluid.

Examination of the right PLF 1 region and the rightmost caudal intercostal areas should demonstrate the right kidney and the duodenum. In a clinically normal horse, there should not be any significant distention or increased wall thickness in the duodenum.

In a clinically normal horse, the ventral region (V1, just caudal to the sternum) may demonstrate the presence of abdominal fluid.

Abdominal Ultrasound of the Horse With Signs of Abdominal Pain

Abdominal ultrasound in the horse with signs of abdominal pain has been most helpful for the detec-
tion and diagnosis of strangulating and nonstrangulation lesions of the small intestine. Each region and subregion of the abdomen is examined ultrasonographically, and the detection of either large intestine and/or small intestine is recorded. Images of the small intestine (jejunum) and duodenum are measured for diameter and wall thickness. The detection of intestinal motility is recorded. Small intestinal motility is defined as contraction and subsequent distention of the small intestinal walls with a change in luminal diameter. In some horses with small intestinal lesions, there is complete absence of small intestinal motility.

Additionally, the nephro-splenic space (left PLF 1 and left PLF 2) is evaluated for either a left dorsal colon displacement or a nephro-splenic entrapment of the large colon. The left intercostal spaces (ribs 10 to 13) are also evaluated for possible distention of the stomach with fluid (gastric reflux).

Horses With Sand Accumulation in the Colon (Sand Colic)
Abdominal ultrasonography of a horse with sand colic usually will not show any distended, amotile loops of small intestine. Some horses with sand colic may show signs of minimally distended small intestine loops filled with fluid or ingesta, which are subsequent to the primary sand colic problem. The gold standard for the detection of sand in the large colon is abdominal radiography (Fig. 4). Abdominal ultrasound of a horse with sand accumulation in the colon will reveal the large colon wall in the ventral region to appear “brighter” and more hyperechoic. This ultrasonographic finding is related to the ultrasonographic reflection of the sand particles (Fig. 5).

Horses With Large Colon Enteroliths and/or Small Colon Enteroliths
Abdominal ultrasonography of a horse with a large colon enterolith or small colon enterolith usually will not show any distended or amotile loops of small intestine but may show minimally distended loops of small intestine that are secondary to the primary problem (colonic enterolith). The gold standard for the detection of an enterolith in the large colon is abdominal radiographs. In the author’s opinion, colonic enteroliths are not detectable with abdominal ultrasound.

Horses With Peritonitis, Ruptured Intestines, Abdominal Fluid Analysis
Abdominal ultrasonography of a horse with peritonitis will usually show several slightly distended loops of small intestine with a very thickened small
intestinal wall (Fig. 6). The small intestinal motility may vary. The thickened loops of small intestine are usually best visualized in the ventral or inguinal regions. The ventral 1 region (close to the sternum) may reveal an increased amount of abdominal fluid. The abdominal fluid may be “gray” or hazy in appearance. In some horses, it is possible to visualize the actual cause of the peritonitis such as an intestinal or mesenteric abscess (Fig. 7, A and B).

A horse with intestinal rupture will have a varying amount of increased abdominal fluid and varying stages of distended and edematous loops of small intestine (Fig. 8). The appearance may vary, depending on the time interval from rupture to abdominal ultrasound examination.

Abdominal ultrasonography can be helpful in locating an area in the ventral abdominal region with an increased amount of abdominal fluid, in order to perform abdominocentesis (Fig. 8). Normal abdominal fluid should appear anechoic or “black” on the ultrasound screen.

Gastric Distention With Fluid (Reflux)

The equine stomach is located between ribs 10 and 13 on the left side of the abdomen. It is the author’s opinion that a normal equine stomach will not show any evidence of gastric fluid. The outer wall of the stomach can be identified and shows a similar appearance as the wall of the large colon. Once the stomach is filled with fluid or reflux, the lesser and greater curvature will become visible during an ultrasonographic examination (Fig. 9). The amount of gastric distention seen on ultrasound will depend on the quantity of gastric reflux. A horse with a distended, fluid-filled stomach should have a stomach tube placed to further evaluate the horse for the presence of gastric reflux.

Horses With Anterior Enteritis

Abdominal ultrasonography of a horse with anterior enteritis usually will reveal a fluid-filled stomach.
caused by gastric reflux on the left side of the abdomen. The duodenum is usually also distended and may appear edematous and possibly amotile. The duodenum is visible cranial to the right paralumbar fossa 1 region in the right caudal intercostal spaces. Further examination of the right paralumbar fossa and ventral region will reveal several slightly distended but very edematous loops of small intestine with decreased motility. A horse with anterior enteritis may have an increased amount of abdominal fluid in the cranioventral abdominal region.

Horses With Strangulating Obstruction of the Small Intestine
Abdominal ultrasonography of a horse with a strangulating obstruction of the small intestine will show several distended loops of small intestine adjacent to each other (three to eight loops of small intestine per field) with either slow small intestinal motility or no small intestinal motility (Fig. 10). Some of the distended loops of small intestine can be thickened or edematous. Most of the distended loops of small intestine can be visualized in the right lower paralumbar fossa region (right PLF 3), ventral regions, or inguinal regions. The cranial abdomen may reveal an increased amount of free abdominal fluid, and the stomach may be filled with gastric fluid due to reflux.

Horses With Right Dorsal Colon Displacement
Horses with a right dorsal colon displacement will not have a distinct ultrasonographic appearance. There may be many slightly distended loops of small intestine that are filled with ingesta. The small intestinal changes seen are usually secondary to the primary large intestinal problem. The colonic wall usually is not edematous, but the colonic vessels may be very distended in the right paralumbar fossa region, and the vessel walls may be edematous.

Horses With Nephro-Splenic Entrapment of the Large Colon and Left Dorsal Colon Displacement
Abdominal ultrasonography in horses with a “true” nephro-splenic entrapment of the large colon, defined as colon located in the nephro-splenic space between the dorsal edge of the spleen and the left kidney, the left kidney cannot be visualized, the typical appearance of the rounded, caudodorsal border of the spleen is lost, and a colonic gas shadow is seen next to the dorsal edge of the spleen (Fig. 11). Horses may have varying amounts of gastric fluid and may have signs of slightly distended loops of small intestine with reduced small intestinal motility; however, these small intestinal changes are secondary to the primary large intestinal problem.

In horses with a left dorsal colon displacement, defined as colon located dorsal to the spleen and not in the nephro-splenic space, the left kidney may either be fully visualized or only partially visualized. The typical appearance of the rounded, caudodorsal

Fig. 9. Distended stomach with gastric reflux.

Fig. 10. Multiple distended loops of small intestine with no evidence of motility indicating a strangulation obstruction.
border of the spleen is either completely or partially lost, and a colonic gas shadow is seen next to the dorsal edge of the spleen. The entire dorsal edge of the spleen cannot be visualized from cranial to caudal, and instead colon wall will be seen (Fig. 12). Usually these horses respond to treatment with intravenous fluid therapy and intravenous phenylephrine therapy. Upon resolution of the displacement, the dorsal edge of the spleen will become visible next to the left kidney on consecutive abdominal ultrasound exams.

Validation of Abdominal Ultrasonography for Horses With Abdominal Pain
During a 7.5-year study period, the following procedures were performed on horses admitted to Chino Valley Equine Hospital for signs of colic: physical examination, complete blood count (CBC), abdominal fluid analysis (total protein, cytologic examination, white blood cell count), placement of a nasogastric tube to obtain gastric reflux, abdominal palpation per rectum by a senior clinician, abdominal radiography, and ultrasonographic examination of the abdomen. Horses were excluded from the study if they were unable to be examined ultrasonographically because of fractious behavior or uncontrollable abdominal pain.

During the study period, 3092 horses with signs of colic were evaluated with abdominal ultrasonography. Of these horses, 1526 were treated medically (49.4%), 1477 underwent exploratory celiotomy (47.8%), and 89 horses were euthanatized (2.9%).

Medical Cases
Of the medically treated horses, 436 of 1526 (28.6%) had no small intestine visualized during the abdominal ultrasound examination, and 1080 (70.8%) had a few normal-appearing loops of small intestine visualized. Several very small loops of small intestine were detected next to the ventral edge of the spleen and/or in the caudal inguinal region. Forty-one (3.8%) appeared to have a gas shadow next to the dorsal edge of the spleen and were treated medically for a possible left dorsal colon displacement. Ten (0.6%) horses appeared to have increased numbers of distended small intestine loops but showed good motility.

Euthanasia With Postmortem Examination Group
Forty-six of 89 euthanatized horses (51.7%) did not appear to have any distended loops of small intestine on abdominal ultrasound. Necropsy examination confirmed that the cause of the colic was unrelated to the small intestine.

In 43 euthanatized horses (48.3%), abdominal ultrasound revealed distended loops of small intestine. In 33 of these horses, an ultrasonographic diagnosis of a strangulation obstruction was made and confirmed during necropsy examination. The remaining 10 horses appeared to have small, very edematous loops of small intestine secondary to peritonitis from a ruptured viscus.

Surgical Small Intestine Group
A strangulation obstruction was diagnosed in 255 horses with the help of abdominal ultrasound and
confirmed during exploratory celiotomy. All 255 cases required a small intestinal resection and anastomosis. A diagnosis of nonstrangulating small intestinal obstruction was made in 141 horses. In 139 of these horses, the primary cause of colic was confirmed to be related to the small intestine on exploratory celiotomy and required a small intestinal resection. Two horses of the 141 horses were found to have a primary large colon problem with a secondary small intestinal component.

In 49 horses, the abdominal ultrasound revealed several small but very edematous loops of small intestine. In every case, an exploratory celiotomy confirmed the preoperative diagnosis of abnormal small intestine.

Surgical Large Intestine Group

In 555 horses, a preoperative abdominal ultrasound revealed no evidence of small intestinal abnormalities. In 412 horses, preoperative ultrasound revealed mainly findings related to the large intestine, with only a few loops of small intestine that showed minimal small intestinal distention. In all 412 cases, exploratory celiotomy confirmed the ultrasonographic findings of a large intestinal lesion. In 14 cases, a preoperative ultrasonographic diagnosis of a left dorsal colon displacement was made. None of these horses responded to medical therapy, and an exploratory celiotomy confirmed left dorsal colon displacement. In 51 cases, a preoperative presumptive diagnosis of nephro-splenic entrapment of the large colon was made on the basis of abdominal ultrasound. In all 51 cases, the preoperative findings were confirmed.

2. Discussion

Previous studies have confirmed the utility of abdominal ultrasonography for the evaluation of horses with signs of colic. In one study, Klohnen et al. evaluated the use of diagnostic ultrasonography in horses with signs of acute abdominal pain. In this study, abdominal ultrasonography showed 100% sensitivity and specificity to diagnose strangulation obstructions of the small intestine.

In the current study described in this report, abdominal ultrasonography was very helpful to distinguish between medical problems and surgical disorders of the large colon and small intestine. In horses with medical colic or in horses with large colon disorders, either no small intestinal distention or only multiple loops of slightly distended small intestinal loops were seen. Overall, this large case series validates the utility of abdominal ultrasonography in the evaluation of equine colic patients. Most importantly, abdominal ultrasonography should be recognized as extremely valuable to determine strangulating obstructions of the small intestine.

Abdominal Ultrasound to Detect and Monitor Postoperative Ileus

Postoperative ileus is an important cause of morbidity and mortality in the postsurgical period for horses with colic. The diagnosis has classically been made on the basis of postoperative reflux obtained through nasogastric intubation and postoperative signs of abdominal pain in conjunction with reflux. According to the veterinary literature, postoperative ileus has mainly been defined by the volume of reflux that is recovered from a horse during a 24-hour period. Abdominal ultrasonography is a proven diagnostic modality in the preoperative diagnosis of small intestinal lesions and is potentially a useful diagnostic imaging technique to assess distention, contractility, wall edema, and motility of small intestine after surgery. In a study of 830 postoperative cases at our clinic, postoperative ileus was defined as the presence of multiple (n > 3) distended loops of small intestine with decreased intestinal contractility and motility. Horses were evaluated every 24 hours after surgery until there was no further evidence of small intestinal distention.

The diagnosis of ileus was established, horses were treated with a slow IV lidocaine bolus (1.3 mg/kg over 15 minutes) followed by an infusion of 0.05 mg/kg per minute of lidocaine in saline until complete ultrasonographic resolution of postoperative ileus was achieved. Of the 213 horses that showed ultrasonographic evidence of postoperative intestinal ileus, 130 (61%) had no evidence of nasogastric reflux, whereas 83 horses (39%) had reflux. Sixty-seven of these horses (32%) were diagnosed with a large intestinal lesion, representing 19% of horses with a primary diagnosis of large intestinal disease during the study period. Sixty-eight percent (146 horses) were diagnosed with a primary small intestinal lesion, which represented 37% of horses with a primary diagnosis of small intestine disease.

We have found that abdominal ultrasound is a reliable method for the diagnosis and monitoring of postoperative intestinal ileus and may provide a more useful indicator than volume of gastric reflux.

Reference


Suggested Reading


