Recent Advances in Equine Abdominal Ultrasonography of the Foal  

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Introduction

Ultrasonography is invaluable in the diagnosis of the cause of colic in foals. The sonographic findings can aid the veterinarian in determining if the foal has a medical or surgical colic. Diagnostic ultrasonography provides a window for noninvasive visualization of abdominal organs and gastrointestinal viscera, which are otherwise difficult to examine. This sonographic information can be used to decide if surgical intervention is indicated, to formulate a prognosis based upon the abnormalities detected and can be used to monitor response to medical treatment. The foal’s abdomen in small and easily evaluated sonographically with the standard linear array 7.5 and 5.0 MHz transducers available with most portable ultrasound machines present in equine practice. If higher frequency transducers are available, they will yield superior images of the gastrointestinal viscera, bladder and umbilical remnants. The technique is noninvasive, can usually be performed without sedation and is well tolerated by most foals.

Patient Preparation and Scanning Technique

The ultrasonographic evaluation of the abdomen is well tolerated and sedation is rarely needed. The hair must be clipped off the skin over the area under investigation with a number 40 surgical clipper blade or shaved, the skin cleaned and an ultrasonographic coupling gel applied. The entire ventral abdomen should be clipped (see diagram).

![Figure 1. Clip diagram for abdominal ultrasonography in the foal (from Pediatric abdominal ultrasonography. In: Reef VB (Ed). Equine Diagnostic Ultrasound, Philadelphia: W.B. Saunders Co. 1998;364-403). - To view this image in full size go to the IVIS website at www.ivis.org . -]

The foal should be scanned standing, if possible. The intraluminal bowel gas will rise to the more dorsal portions of the abdomen, enabling the clinician to examine a larger portion of the gastrointestinal tract. If the foal is recumbent, the scan should be performed from the most ventral portion of the abdomen. A high frequency transducer should be used initially to perform these examinations (6.0 - 10.0 MHz or higher), as this will yield superior images of the bowel. A lower frequency transducer can then be selected to complete the examination if penetration is inadequate.

Normal Ultrasonographic Findings in the Foal’s Gastrointestinal Tract

Both large and small intestinal echoes are usually imaged from the ventral abdomen in the foal, while primarily large intestinal echoes are usually imaged in the intercostal spaces (ICS) and the flank. The large intestinal echoes are recognized by their large semi-curved, sacculated appearance, except for the right dorsal colon. The right dorsal colon has a smoother nonsacculated appearance and is usually imaged from the right 14th – 10th intercostal spaces. The large intestinal wall is hypoechoic to echogenic with a hyperechoic gas echo from the mucosal surface and normally measures 3 mm or less in thickness. Peristaltic activity is normally visualized. The small intestinal echoes are recognized by their small tubular and circular appearance. The wall of the jejunum is hypoechoic to echogenic with a hyperechoic echo from the mucosal surface and is usually 3 mm or less in thickness. Some anechoic fluid and hyperechoic gas is often imaged in the lumen of the jejunum. Peristaltic waves are also normally visualized. The duodenum is imaged around the caudal pole of the right kidney and medial to the right liver lobe at the level of the pylorus. It appears small circular (when sliced in its short axis) with a hypoechoic to echogenic wall, also < 3mm in thickness, and has a fluid lumen. The duodenum usually appears partially collapsed and its peristaltic motion is easily visualized during real-time scanning. The gastric fundic echo is visualized in the
left 9 - 12th ICS and is imaged as a large semi-circular structure medial to the spleen at the level of the splenic vein. In the neonate the stomach is also imaged from the ventral abdominal window, caudal to the liver. The gastric wall is hypoechoic to echogenic with a hyperechoic gas echo from the mucosal surface and normally measures up to 7.5 mm in thickness.

**Surgical Colics**

**Herniation/Displacement** - Abnormal positioning of the gastrointestinal viscera is difficult to diagnose ultrasonographically, unless the viscera are displaced into the scrotum, thoracic cavity or into an umbilical hernia.

![Figure 2. Small intestine within scrotal sac. - To view this image in full size go to the IVIS website at www.ivis.org . -](image)

Displacement of the gastrointestinal viscera into the thoracic cavity through a diaphragmatic hernia can usually be diagnosed ultrasonographically by scanning the affected side of the thorax and cranial abdomen and looking for the rent in the diaphragm, as displacement of the overlying lung by the herniated viscera occurs. The approximate size of the diaphragmatic hernia can be estimated and the gastrointestinal viscera evaluated for the degree of bowel compromise. However, a diaphragmatic hernia could be missed ultrasonographically if it was located in the center of the diaphragm and the herniated viscera were not in contact with the thoracic wall. In foals with umbilical hernias, the contents of the hernial sac, the integrity of any incarcerated bowel, the presence of any adhesions and the size of the hernia can be identified. In foals with scrotal hernias, the contents of the hernia can be determined ultrasonographically.

**Bezoars** - Bezoars can be diagnosed ultrasonographically, if the affected portion of bowel is scanned, as these disorders make the bowel much heavier than normal causing it to fall towards the floor of the ventral abdomen. With a bezoar a large, hyperechoic mass, casting a strong acoustic shadow, will be imaged within the lumen of the intestine, if the affected portion of intestine is adjacent to the body wall.

**Intussusceptions** - Intussusceptions have a characteristic target or bull’s eye sign in the affected portion of intestine. There are many different possible sonographic appearances for the intussusception, depending upon which portion of the intussusception is being imaged. Often fibrin is imaged between the 2 loops of affected intestine. In foals the intussusception is usually jejunal and is imaged from the ventral most portion of the abdomen.

![Figure 3. Jejunal-jejunal intussusception. - To view this image in full size go to the IVIS website at www.ivis.org . -](image)

**Strangulating Small Intestinal Lesions** - Distended, fluid-filled small intestine is usually imaged proximal to a strangulated portion of small intestine. The strangulated small intestine usually has thickened, edematous, hypoechoic walls with little or no peristaltic activity. Complete volvulus of the small intestine may also occur, similarly affecting the entire small intestine. Distended small intestine with thickened walls is most frequently detected in the ventral portion of the abdomen, as the increased weight of these loops brings them in contact with the ventral portion of the abdomen.

**Small Intestinal Masses** - Masses within the intestinal wall are thickened areas, often compromising the lumen of the affected portion of intestine, which may be anechoic to echogenic, depending upon their etiology. Mural masses are frequently imaged in neonatal foals with periparturient asphyxia syndrome and obstruction.
Meconium Impaction -
Meconium impactions are imaged in the caudal portion of the gastrointestinal tract of foals and can appear as hypoechoic, echoic or hyperechoic masses in the lumen of the large colon, small colon or rectum. If the meconium is obstructing the flow of ingesta, the small colon proximal to the obstruction will be fluid distended.

![Figure 4. Meconium in cecum.](www.ivis.org)

Scanning for a meconium impaction should always include scanning from the ventral abdomen, using the bladder as an acoustic window to image the small colon and rectum dorsal to the bladder as well as the entire abdomen. In older foals, Ascarid impactions can be imaged in the bowel lumen, usually in the ileum. Paralyzed Ascarid worms can be imaged in the lumen of the large colon in many affected foals within fluidy ingesta.

Medical Colics
Enteritis/Duodenitis -
Fluid distension of the intestinal tract with increased peristalsis indicates developing enteritis. The wall of the affected portion of the intestine may be thickened, edematous and more hypoechoic than normal, particularly with severe inflammatory bowel disease. Shreds of intestinal mucosa may be imaged in the lumen of the intestinal tract. Marked thickening of the intestinal wall has been imaged in foals with *Lawsonia* infection.

![Figure 5. Marked small intestinal thickening in foal with *Listeriosis*.](www.ivis.org)

Marked fluid distension of the stomach should prompt gastric decompression. Fluid distention of the duodenum can also be imaged with anterior enteritis and other more distal obstructions. The lack of motility in these intestinal segments is consistent with an ileus and the thickness and echogenicity of the bowel wall are an indication of the degree of involvement of the bowel wall.

![Figure 6. Duodenitis in a foal.](www.ivis.org)

Foals with proximal duodenitis may have a history of colic and have elevated biliary enzymes and an associated cholangiohepatitis. The liver is imaged from the right and left sides of the abdomen in the older foal, ventral to the ventral most lung margins (right 6th - 15th ICS and left 7th - 9th ICS). In neonates for the first 4 weeks, the liver is also imaged from the ventral abdominal window, caudal to the xiphoid. In most foals a 6.0 - 10.0 MHz transducer yields superior images of the liver but a lower frequency transducer may be needed in older weanlings. Foals with cholangiohepatitis or biliary obstruction usually have larger than normal livers, with increased echogenicity of the hepatic parenchyma. Biliary distension, sludging of bile within the ducts and thickening of the bile ducts may be imaged in the biliary tree.

Gastric Distention -
Gastric emptying problems may be identified sonographically if large amounts of milk or ingesta persist unchanged in the stomach in a fasted, anorexic or refluxing foal on repeat examinations. The distended stomach is usually slightly less circular than normal, with anechoic to hypoechoic fluid in the lumen of the stomach.

Abdominal abscess -
Abdominal abscesses in foals are usually found in the ventral portion of the abdomen associated with the mesentery of the gastrointestinal tract. These abscesses may be anechoic, hypoechoic or filled with echoic material and are often
multiloculated. Hyperechoic echoes representing free gas may be detected suggesting concurrent anaerobic infection. Large and/or small intestine may be adhered to the wall of the abscess and its motion restricted.

**Peritonitis**
Characterization of the peritoneal fluid can be performed ultrasonographically from the ventral abdomen, usually with a 7.5 - 10.0 MHz transducer. If a large quantity of peritoneal fluid is present, the use of a 5.0 - 6.0 MHz transducer may be indicated, to further evaluate the abdomen. The relative quantity and character of the peritoneal fluid, (hypoechoic, swirling, homogeneous fluid or echogenic, flocculent, composite fluid, fibrin and/or adhesions between the serosal surfaces of the intestine and the abdominal wall) should be assessed. The detection of hypoechoic or echogenic, flocculent, composite fluid, fibrin and/or adhesions between the serosal surfaces of the intestine and the abdominal wall is compatible with peritonitis. The abdomen and associated gastrointestinal and abdominal viscera should be thoroughly scanned for the source of the peritonitis such as an abdominal abscess or devitalized area of bowel. Free gas echoes and/or particulate echogenic debris are consistent with a ruptured viscus.

Homogeneous, hypoechoic to echogenic cellular fluid is imaged with hemoperitoneum, which is usually distinguished from septic fluid by the detection of swirling fluid, associated with movement of the gastrointestinal viscera and respiration and the settling and stirring of blood components. The kidneys, liver and spleen should be carefully examined in foals and adults with hemoperitoneum to determine if these organs are the cause of the hemorrhage.

**Uroperitoneum**
Foals with uroperitoneum are usually male, less than one week old and present with a gradually distending abdomen and depression. Ultrasonographic evaluation of foals with suspected uroperitoneum results in a rapid confirmation of the diagnosis and localization of the probable site of the defect prior to surgical intervention. If the site is not located to the bladder or urachus, a thorough work-up should be performed prior to surgery to determine if a ureteral defect or defects are present. Ultrasonography has been useful in the diagnosis of subcutaneous urachal rupture, localizing ureteral abnormalities and identifying urethral calculi in foals.

In most foals with uroperitoneum, a large quantity of anechoic fluid is present in the abdomen with the gastrointestinal viscera floating in the fluid. Uroperitoneum is most frequently associated with a ruptured bladder in the foal. In these foals the bladder is collapsed, folded on itself and contains little or no fluid (urine). The defect in the bladder wall is often not visible.

Urachal ruptures are also common and appear as an intact fluid filled bladder with fluid dissecting out along the urachus and in the retroperitoneal space along the ventral abdomen. A ureteral rupture or defect is rare and is the most difficult to diagnose sonographically. An intact, fluid-filled bladder and a large volume of anechoic abdominal fluid are imaged in these foals. If the defect is near the kidney, retroperitoneal fluid (urine) is imaged surrounding the kidney. A necrotizing cystitis resulting in uroperitoneum appears as a thick hypoechoic to anechoic bladder wall that may appear somewhat rigid. In foals with necrotizing cystitis the majority of the bladder wall is usually affected and needs to be resected. The majority of foals with necrotizing cystitis are older, usually 3 weeks of age or more. Severe omphaloarteritis or urachitis can occasionally result in the development of uroperitoneum, usually in 3 - 4 week old foals.

**Normal Ultrasonographic Findings in Foal Kidneys**
Both kidneys can be scanned transcutaneously. The right kidney is usually found in the right 14th through 16th intercostal
space, between a line drawn level with the dorsal and ventral most aspects of the tuber coxae. This kidney is retroperitoneal and is immediately underneath the abdominal wall. This kidney can usually be visualized with a 6.0 - 10.0 MHz transducer in the foal. The left kidney is located slightly more ventrally, medial to the spleen, and thus is further away from the abdominal wall. This kidney is located in the 17th intercostal space and/or paralumbar fossa, between a line drawn level with the tuber coxae and the tuber ischi. Scanning this kidney in foals with a 6.0 - 10.0 MHz transducer usually yields superior images. The kidneys are normally the least echogenic organs in the abdomen.

Ultrasonographic Findings in Foals with Renal Disease
Enlarged sonolucent kidneys may be imaged in some foals with acute renal failure. Occasionally, perirenal edema may also be imaged in these individuals. Wedge shaped areas of increased echogenicity in the renal cortex are consistent with renal infarcts. Increased echogenicity of the renal parenchyma is usually associated with chronic renal disease, along with kidneys that are smaller than normal and irregular in contour, particularly if the renal disease is end stage. Increased echogenicity of the renal parenchyma is often seen with infiltrative renal disease. Congenital renal abnormalities are unusual, but can be characterized ultrasonographically. Renal and perirenal hematomas can also occur, associated with severe trauma.

Normal Ultrasonographic Findings in the Foal Liver
The liver can be imaged from the right and left sides of the abdomen and from the ventral abdomen, just caudal to the xiphoid, in the neonatal foal. The liver is normally imaged ventral to the lung margins on the right side from the 6th through the 15th intercostal spaces and on the left side from the 7th to 9th intercostal spaces. In most foals a 6.0 - 10.0 MHz transducer yields superior images of the liver. The liver is recognizable by its branching vascular pattern. The bile ducts are not normally visualized. The majority of the liver is visible ultrasonographically only in neonatal foals. Thus, estimations about hepatic size are based upon the amount of hepatic parenchyma visualized ventral to the ventral lung margins in older foals.

Ultrasonographic Findings in Foals with Hepatic Disease
With acute hepatocellular necrosis, collapse of the hepatic parenchyma may be detected. The hepatic parenchyma is more hypoechoic than normal and the liver appears smaller than normal. In contrast, foals with cholangiohepatitis or biliary obstruction usually have larger than normal livers, with increased parenchymal echogenicity. Biliary distension and sludging of bile within the ducts may be imaged in the biliary tree in foals with cholangiohepatitis. Liver fracture and abscesses in the liver are rare in foals, but can be diagnosed ultrasonographically.

Normal Ultrasonographic Findings in the Foal Spleen
The spleen is the most echogenic organ in the abdomen and is normally visualized in the left side of the abdomen, ventral to the lung margins from the 7th or 8th intercostal space to the paralumbar fossa on the abdominal side of the diaphragm. The spleen can often be imaged along the ventral floor of the abdomen and is occasionally visible from the right cranial abdomen as well. The spleen is recognized by its more granular homogeneous texture with few vessels coursing throughout. The spleen may be as thick as 15 cm in its mid body.

Ultrasonographic Findings in Foals with Splenic Disease
Splenic abnormalities are rare in foals with splenic hematomas being the most likely pathology to be detected, occurring in foals with abdominal trauma. Splenic hematomas appear as anechoic to echoic masses within the splenic parenchyma, usually in a foal with hemoperitoneum.

References

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