Recent Advances in Abdominal Ultrasonography of the Adult Horse  (16-Dec-2003)

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Introduction
Ultrasonography is invaluable in the diagnosis of the cause of colic in adult horses. The sonographic findings can aid the veterinarian in determining if the adult horse 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. The horse's abdomen is so large that other techniques for evaluation of the abdominal organs and gastrointestinal viscera (except for rectal palpation, clinic pathological data, and abdominal paracentesis) are all but useless. 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 adult horse’s abdomen should initially be evaluated with a 6.0 - 10.0 MHz transducer with lower frequency transducers used as the deeper portions of the abdomen are investigated. Transrectal ultrasonographic evaluation of abnormalities detected on rectal palpation can also be performed to further clarify the rectal findings.

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. The horse 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 horse 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), 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 Equine Gastrointestinal Tract
Only large intestinal echoes are usually imaged in the intercostal spaces (ICS) and the flank. Occasionally small intestinal echoes are imaged between the stomach and spleen and in the caudal ventral abdomen of the adult horse. 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. 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. Gastric rugal folds can be often be imaged in adult horses.
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 1. Diaphragmatic hernia with hemothorax.](www.ivis.org)

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 horses with abdominal wall hernias or ruptures of the prepubic tendon, diagnostic ultrasonography can be used to measure the size of the defect, so an appropriately sized piece of mesh can be prepared preoperatively for implantation. Furthermore the contents of the hernial sac and the presence of any adhesions can be identified and the hernial ring described. Hernias in the adult horse should also be scanned with the 6.0 - 10.0 MHz transducer and if they are large, a lower frequency transducer may also be needed to fully evaluate the contents of the hernial sac.

Nephrosplenic Ligament Entrapment -
Diagnosis of a nephrosplenic ligament entrapment is suspected ultrasonographically, based upon the inability to visualize the spleen or left kidney transabdominally and the visualization of ingesta and/or gas filled large bowel instead. The sonogram can be used to see if treatment with phenylephrine, followed by lunging, or rolling the horse has successfully corrected the nephrosplenic ligament entrapment.

Sand Colic/enterolithiasis -
Sand colics, bezoars and enteroliths can all 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 to the floor of the ventral abdomen. With an enterolith or 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 ventral body wall. Distention of the more proximal portion of the intestine by the obstructing bezoar or enterolith is also detectable. However, most enteroliths are not located in a position where they are imageable ultrasonographically. Small, pinpoint granular hyperechoic echoes, casting multiple acoustic shadows, will be imaged in the ventral most portion of the affected intestine in horses with sand colic, weighing down the intestine and limiting its peristaltic movement.

Intussusceptions -
Intussusceptions in adult horses usually involve the ileum and/ or large bowel. The majority of intussusceptions imaged in adult horses are imaged from the right side of the abdomen because the cecum or right ventral colon are involved.

![Figure 2. Cecolic intussusception.](www.ivis.org)

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 yearlings and young horses, ileal intussusceptions are more common and may be imaged rectally or transcutaneously.
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. Intestinal carcinoids, leiomyomas, granulomas, hematomas and fibrosis have all been reported to cause small intestinal obstruction. Hemorrhage in the lumen of the intestine often appears as echogenic clots or echoic swirling fluid. Areas of mural stricture have been imaged in several horses with chronic colic that were ultimately surgically resected. Thickening of the wall of the ileum in yearlings and horses with ileal hypertrophy can also be detected sonographically both transrectally and transcutaneously.

Impaction -
An impaction can often be imaged from the flank or side of the abdomen in horses with cecal or right dorsal colon impactions. Small colon impactions may be imaged transrectally, when scanning the caudal abdomen, as echogenic intraluminal masses. Distension of the more proximal portion of intestine, proximal to an impaction, is usually present, making ultrasonographic visualization of the impaction easier. Small colon impactions have also been imaged from the flank in miniature horses. Impactions can only be imaged sonographically when the impacted portion of the large colon or cecum is adjacent to the body wall or fluid is interposed between the affected portion of the intestine and the body wall. The impaction appears as a round to oval distended viscus, often measuring 20 - 30 cm or more, lacking any visible sacculations. The bowel wall may be normal thickness or may be thicker than normal and there is a large acoustic shadow cast from the impacted ingesta adjacent to the colonic mucosa. In larger horses, small or large colon impactions can be imaged transrectally if palpable. Little to no motility of the affected portion of the intestinal tract will also be imaged in horses with impactions, compromised intestinal segments, or enterolithiasis.

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 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. Adults with proximal duodenitis/ anterior enteritis may have an associated cholangiohepatitis with elevated biliary enzymes. The liver is imaged from the right and left sides of the abdomen in the adult horse, ventral to the ventral most lung margins (right 6th - 15th ICS and left 7th - 9th ICS). In adults a 5.0 or 3.5 MHz transducer is usually needed to adequately examine the liver. Adults 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.
Right Dorsal Colitis -
Right dorsal colitis associated with nonsteroidal anti-inflammatory drug toxicity can be diagnosed ultrasonographically by detecting a thickened right dorsal colon ventral to the liver in the right 10th - 14th intercostal spaces. The wall of the right dorsal colon is usually irregularly thickened with increased or variable echogenicity of the bowel wall detected sonographically.

Verminous Arteritis -
Verminous arteritis can be imaged ultrasonographically if the affected vessel is imageable transrectally. The affected vessel wall is thickened and large plaque-like or mass lesions can be imaged along the intimal surface of the vessel, invading the arterial lumen.

Gastric Distention -
Gastric emptying problems may be identified sonographically in the adult horse if large amounts of ingesta persist unchanged in the stomach in a fasted, anorexic or refluxing horse on repeat examinations. The sonographic appearance of a gastric impaction is a markedly enlarged gastric echo extending over 5 or more intercostal spaces on the left side of the abdomen. The stomach is usually slightly less circular than normal, with hyperechoic material casting an acoustic shadow in the lumen of the stomach. In one horse the enlarged stomach was also imaged for several intercostal spaces on the right side of the horse's abdomen. Gastric squamous cell carcinomas are not uncommon in older horses and a complex pattern of echogenicity can be seen in the wall of the stomach in affected horses, often with invasion into the adjacent spleen or liver parenchyma.

Intestinal Neoplasia -
Masses within the intestinal wall are most likely to occur in adult horses with lymphosarcoma or granulomatous enteritis. Neoplasms affecting the wall of the gastrointestinal tract such as lymphosarcoma, although relatively common in adult horses, are not routinely visualized upon transabdominal ultrasonographic examination of the abdomen. If abnormal loops of bowel are palpable rectally, rectal ultrasonographic examination would enable further characterization of the mass invading the intestinal wall. Lymphosarcoma usually has a relatively homogeneous soft tissue density appearance when imaged in areas outside the spleen, unless severe tissue necrosis has occurred or the tumor is very aggressive.

Abdominal Abscess -
Abdominal abscesses in the adult horse may be detected in the ventral abdomen, but are also frequently found dorsally associated with the root of the mesentery, cecum and large colon. Abdominal abscesses have also frequently been reported in the adult horse associated with the liver. The sonographic appearance of the abscess and its relationship to the surrounding intestine and abdominal organs can be usually determined in the adult, as in the foal.

Peritonitis
Characterization of the peritoneal fluid can be performed ultrasonographically from the ventral abdomen, usually with a 6.0 - 10.0 MHz transducer. If a large quantity of peritoneal fluid is present, the use of a 5.0 MHz or lower frequency 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 adults with hemoperitoneum to determine if these organs are the cause of the hemorrhage.

Uroperitoneum
Uroperitoneum is rare in the adult horses but when it occurs is often associated with abdominal pain. Uroperitoneum has been associated with traumatic parturition in mares or urethral obstruction in stallions or geldings. In most adult horses 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 adult horse. The bladder is collapsed, folded on itself and contains little or no fluid (urine). The defect in the bladder wall is often not visible.

Normal Ultrasonographic Findings in Equine Kidneys
Both kidneys can be scanned transabdominally and the left kidney can be scanned transrectally in the adult horse. 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 5.0 or 3.5 MHz transducer in the adult horse. 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 ischii. Scanning this kidney in the adult horse often requires a 2.5 MHz transducer. The kidneys are normally the least echogenic organs in the abdomen, although normal older horses often have renal echogenicity similar to or even increased over that of the liver. Rectal ultrasonographic examination of the left kidney in the adult horse usually yields superior images and can be most successfully performed using a 5.0 - 10.0 MHz transducer.

Ultrasonographic Findings in Horses with Renal Disease
Enlarged sonolucent kidneys may be imaged in some horses 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 and may reflect the infiltration of inflammatory, fibrous, granulomatous, or neoplastic cells into the renal parenchyma. Renal calculi are not uncommonly reported in horses, usually associated with chronic end stage renal failure. Obstruction of the ureter or renal pelvis, resulting in hydronephrosis or hydroureter (the ureter is not normally visualized when the horse is scanned transcutaneously), may be detected ultrasonographically, associated with nephrolithiasis.

An enlarged renal pelvis filled with hypoechoico to echogenic debris may be imaged in horses with pyelonephritis. Renal tumors are also unusual in horses. The most common renal tumor is a renal papillary adenocarcinoma, which usually has a complex pattern of echogenicity and completely destroys the normal renal architecture. Lymphosarcoma may be imaged as a more homogeneous mass infiltrating the kidney (most common), although may have a more heterogeneous appearance (complex pattern) in some affected horses. Halicephalobus gingivalis can also cause large homogeneous soft tissue density masses in the kidneys that bulge from the surface of the kidney. Renal and perirenal hematomas can also occur, associated with severe trauma.
Normal Ultrasonographic Findings in the Equine Liver

The liver can be imaged from the right and left sides of the abdomen in the adult and from the ventral abdomen, just caudal to the xiphoid. 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 adult horses a 5.0 MHz transducer yields superior images of the liver, unless the horse has an increased amount of subcutaneous and retroperitoneal fat, necessitating the use of a lower frequency transducer (3.5 or 2.5 MHz). The liver is recognizable by its branching vascular pattern. The bile ducts are not normally visualized. The majority of the liver is not visible ultrasonographically, nor is the caudal vena cava, in a normal adult horse. Thus, estimations about hepatic size are based upon the amount of hepatic parenchyma visualized ventral to the ventral lung margins. Hepatic atrophy commonly occurs with increasing age in the horse; therefore, in older horses only a small amount of hepatic parenchyma is normally visualized.

Ultrasonographic Findings in Horses 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, horses with cholangiohepatitis or biliary obstruction usually have larger than normal livers, with increased parenchymal echogenicity. Biliary distension, sludging of bile within the ducts, thickening of the bile ducts and hepatoliths may be imaged in the biliary tree. The obstructing hepatoliths are most commonly found cranioventrally, in the 6th through 9th intercostal spaces, while biliary distension is usually imaged caudodorsally. Hepatoliths are usually hyperechoic and cast acoustic shadows.

Increased echogenicity of the hepatic parenchyma occurs with granulomatous, inflammatory, fibrotic, neoplastic or fatty infiltration of the liver. A more complex pattern of echogenicity is usually seen in horses with hepatic neoplasia. Hepatic lymphosarcoma may have a uniform homogeneous appearance with diffuse infiltration of the liver or may be imaged as homogeneous or complex, composite masses within the hepatic parenchyma. Hepatic neoplasia, liver fracture, and abscesses in the liver are rare in horses, but can be diagnosed ultrasonographically.

Normal Ultrasonographic Findings in the Equine 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 Horses with Splenic Disease

Splenic abnormalities are rare in the horse, with the exception of lymphosarcoma, in which masses with a complex pattern of echogenicity are usually imaged involving the majority (most frequently) of the splenic parenchyma. Granulomatous masses, metastatic neoplasms of other types, and hematomas may also be imaged ultrasonographically but are unusual to find in the spleen of horses.

References

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