Ultrasound of the Thorax and Abdomen in the Foal

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Ultrasoundography in the neonate may be used in the initial evaluation to determine an anatomic location of sepsis or to evaluate for traumatic injury secondary to dystocia. It is often the first diagnostic tool applied after the physical evaluation of the foal. Author’s address: School of Veterinary Science, University of Queensland, Gatton, Queensland 4343, Australia; e-mail: f.bain@uq.edu.au. © 2012 AAEP.

1. Introduction

Ultrasonography has become a routine part of medical examination of the foal and is a valuable tool for acquiring information on structural pathology of organs within the thorax and abdomen. In the neonate, it may be used in the initial evaluation to determine an anatomic location of sepsis or to evaluate for traumatic injury secondary to dystocia. Although we often separate disorders of the thorax and abdomen into distinct categories, both body cavities are usually evaluated during the same ultrasound examination. The ultrasound examination is performed in a cranial-to-caudal manner—passing the ultrasound probe along each intercostal space, scanning from dorsal to ventral, and then sweeping the caudal and ventral abdomen behind and beneath the ribs.

2. Thoracic Ultrasound in the Foal

Disorders of the thorax in the neonatal foal include rib fractures, pneumonia, and effusions (septic, hemorrhagic, or other). Rib fractures are common in hospitalized neonatal foals, and ultrasound is considered a more accurate method of detection compared with radiography and physical examination. Fractures are most often located within 3 cm of the costochondral junction and more commonly involve the first few ribs behind the elbow. Early on, a rib fracture may appear as a “greenstick” fracture (Fig. 1), detected on ultrasound as a slight discontinuity of the external cortical surface. Later, increasing displacement of the fracture site is detected sonographically as more separation of the fracture fragments with the distal segment usually moving medially (Fig. 2). There may be fluid or hemorrhage in the soft tissues surrounding the fracture ends with multifocal echolucent areas (Fig. 3). Some indentation (or step deformation) of the parietal and visceral pleural surfaces may also be detected. Injury to the underlying pulmonary parenchyma can vary from mild bruising with a few echogenic “comet tails” to progressively more involvement with parenchymal consolidation and occasional hemothorax or pneumothorax. Serial evaluation of the degree of displacement is recommended to determine if there is risk of cardiac injury or progressive change in the lung—either might be an indication to consider surgical stabilization versus conservative management of restricted mobility in the stall. Ultrasound can also be useful in monitoring the fracture healing process—determining
when there is sufficient callus formation and fracture stability to allow more exercise. With fracture of more caudal ribs, there may be injury to the diaphragm and possible diaphragmatic hernia with intestinal structures within the pleural space (Fig. 4).

Ultrasound has become a routine tool in the evaluation of pneumonia in the foal. Pneumonia can be a primary anatomic site of sepsis in the neonate. Early identification can be useful in determining the severity of the disease process as well as monitoring the response to medical therapy. Patterns of changes on the ultrasound image can be helpful in predicting the type of lung injury present. Scattered echogenic “comet tails” (Fig. 5) may be present in the early stages of a variety of bacterial pneumonias, with ventral consolidation (Fig. 6) being evident with further progression or more serious pneumonia. Broad-based or diffuse echogenic shadowing is more consistent with interstitial lung disease (pulmonary edema or interstitial pneumonia) and suggests a more serious disease process. Serial ultrasonographic examination of the lung is useful in evaluating the progression of disease and can be a component for evaluating response to medical therapy.

3. Abdominal Ultrasound in the Foal

Ultrasound examination of the abdomen of foals is often used in the evaluation of foals with signs of colic and can be useful in differentiating causes of abdominal distention in foals with and without colic signs. While not the focus of this presentation, ultrasound is useful in evaluation of disorders of the umbilical structures and abnormalities of the abdominal wall surrounding the umbilicus and the inguinal area (e.g., traumatic injury acquired during delivery and congenital defects).

![Fig. 1. “Greenstick,” or nondisplaced rib fracture.](image1)

![Fig. 2. Displaced rib fracture. Note distal fragment (right) displaced medially.](image2)

![Fig. 3. Multifocal echolucent areas adjacent to rib fracture indicating local soft tissue trauma and fluid accumulation.](image3)

![Fig. 4. Ultrasound appearance of pleural effusion and presence of intestinal structures in pleural space consistent with diaphragmatic hernia. Long arrow indicates tip of lung; arrowhead, intrathoracic intestine; short arrow, diaphragm. Dorsal is to the left (image courtesy of Dr. Eric Mueller).](image4)
The approach to the ultrasound examination of the foal with signs of acute abdominal pain is similar to that used for the adult equine patient. There are some special circumstances and lesions that may be unique to the younger foal that must be evaluated. The use of a high-frequency (5 to 7.5 mHz or higher) probe—whether linear or microconvex—is sufficient for imaging much of the abdominal cavity in the young foal with good resolution of structures. This can be performed with the foal standing or in a recumbent position.

The ultrasound examination should proceed as with the adult patient by evaluating the ventral thorax and abdomen by passing the ultrasound probe dorsal to ventral along each intercostal space beginning just caudal to the triceps muscle on each side and progressing in a cranial to caudal fashion to the thigh. The exam is completed by then sweeping the ventral aspect of the abdomen to evaluate the umbilical structures and the urinary bladder.

4. Foals With Abdominal Pain and Abdominal Distension Can Have a Variety of Conditions

These conditions may include gas distension of the large colon in the foal with conditions such as meconium impaction or occasionally colonic tympany associated with early rotavirus infection; small intestinal fluid distension with small intestinal volvulus, or occasionally enteritis or intussusception; and peritoneal fluid accumulation with either uroperitoneum, hemoperitoneum, or peritonitis.

Gastric distension (Fig. 7) can be evaluated in the foal in a manner similar to that seen in the adult. Causes of gastric distension may include ileus with or without enteritis or small intestinal strangulation obstruction. Occasionally and usually in older foals, duodenal stricture (Fig. 8) associated with the
gastroduodenal ulcer syndrome can be identified along the right side of the abdomen; this is helpful in confirming the need for surgical correction. In these patients, the amount of gastric distension may be profound (Fig. 9)—possibly leading to gastric atony later in the course of the disease. Ultrasound can be useful in confirming the proper location of the nasogastric tube when attempting placement for enteral feeding of a weak neonate or refluxing a foal with colic (Fig. 10).

Small intestinal obstructive disorders such as volvulus or entrapment in scrotal hernias will appear similar to that seen in the adult patient—with profoundly fluid-distended segments of small intestine occasionally with sedimentation of particulate material to the ventral or dependent aspect (Fig. 11). With the hernia, small intestinal segments may also be evident within the vaginal tunic.

Small intestinal disorders including enteritis can be easily identified in the foal. The ultrasound finding of fluid distension of the small intestinal lumen along with variable motility and variable thickening (>2 to 3 mm) of the small intestinal wall concurrent with fever and leucopenia is supportive of the clinical diagnosis of enteritis (Fig. 12). The small intestinal wall may often be less distinct with enteritis due to inflammatory cell infiltrates and variable edema of the wall. In many geographic regions around North America, the ultrasound finding of a markedly thickened (>5 mm in some cases) small intestinal wall in older foals together with a syndrome of peripheral edema, hypoproteinemia, and hypoalbuminemia is considered consistent with *Lawsonia intracellularis* infection (Figs. 13 and 14). Peripheral edema of the submandibular space as well as edema of the ventral abdomen and distal limbs are usually consistent clinical signs; however, the presence of colic or diarrhea may be more variable. In some patients affected with *Lawsonia*, there will also be significant thickening of the large colon wall due to mural edema (Fig. 15), presumably associated with the profound hypoproteinemia and hypoalbuminemia associated with this disease.

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Fig. 9. Profound gastric distension associated with duodenal stricture in a foal.

Fig. 11. Distended nonmotile small intestine with sedimentation of particulate matter associated with small intestinal volvulus.

Fig. 10. Acoustic shadow from nasogastric tube within lumen of stomach.

Fig. 12. Ultrasound image of enteritis in the foal with indistinct intestinal wall.
Additional diagnostics such as fecal polymerase chain reaction (PCR) and/or serology can be used to confirm the diagnosis.

Colic associated with small intestinal obstruction from intussusceptions occur more commonly in young foals, often secondary to enteritis or dysmotility secondary to birth asphyxia. Serial ultrasound examinations may be necessary to identify the intussusception, which is classically described as a “target lesion” with the concentric rings of the intussuscepted intestinal wall (Figs. 16 and 17).

Occasionally, the acute onset of rotaviral enteritis will result in variable signs of colic and inappetence, sometimes before the appearance of diarrhea. Abdominal ultrasound can be useful in identifying liquid contents of both the small and large intestines, which may be indicative of impending diarrhea (Fig. 18).

Foals with rib fractures will sometimes present with apparent colic signs. Diaphragmatic hernias associated with rib fractures can occur due to laceration of the diaphragm from rib fractures, or rarely, as a congenital diaphragmatic anomaly, and present with intrathoracic strangulation of the intestine. Other unusual findings in foals with colic may include umbilical vascular disruption, internal organ injury associated with dystocia, and occasionally hemobdomen of unknown origin.

The urogenital system of the foal represents a special system within the abdominal cavity of the
foal for ultrasound evaluation.\textsuperscript{4} Uroperitoneum secondary to rupture of the urinary bladder is the most common abnormality (Fig. 19).\textsuperscript{5} Ultrasound imaging usually demonstrates variable volumes of variably echogenic to hypoechoic peritoneal effusion with free-floating intestinal organs. There are some instances in which the peritoneal fluid associated with uroperitoneum will appear quite echogenic and require differentiation from suppurative exudate associated with septic peritonitis by abdomino-centesis. In cases of uroperitoneum associated with a ruptured urinary bladder, the bladder is usually collapsed and folded on itself. The actual rupture site is usually located on the dorsal aspect of the bladder, although it may not be easily identified on the ultrasound image. It is important to note that ruptures of the urinary tract may occur at sites other than the urinary bladder, such as the urachus or ureters. Urachal ruptures often will have a periumbilical plaque of edema associated with subcutanous leakage of urine. Ureteral ruptures result in accumulation of urine in the retroperitoneal space that may be imaged as hypoechoic fluid surrounding the kidneys. Congenital defects of the kidneys and ureters are occasionally seen. Hydroureter (Fig. 20) can occur in neonates as a congenital condition and can have a clinical presentation of neurologic signs secondary to profound hyponatremia and post–renal azotemia. Dilated tortuous ureters may be seen as fluid-distended tortuous tubes exiting the kidney. Laboratory findings may demonstrate azotemia, hyponatremia, and hypochloridemia similar to that found with uroperitoneum.

5. Summary/Conclusions
Ultrasound imaging is a readily available diagnostic tool that is easily applied to evaluation of the young foal, both in the hospital setting and in the field. In the author’s practice, it is often the first diagnostic tool applied after the physical evaluation of the
foal. In the absence of obvious abnormalities on the physical evaluation, ultrasound provides an “on-the-scene” evaluation of changes in or on the organs of the thorax and abdomen of the foal that can direct the first steps in therapy, before obtaining results of other diagnostics such as hematology or clinical chemistry data. The time frame to reach a level of comfort and confidence for diagnostic ultrasonography of the foal is quite short. The thin body wall of the foal allows ease in observing body cavity structures in excellent detail. A good first start is to evaluate normal foals in an effort to learn the patterns of sonographic appearance of normal internal organs—learning parameters such as location, thickness, diameters, or a variety of structures. Scanning as many foals as possible, whether normal or abnormal, is certainly the best way to gain a broad level of experience in sonographic features. Sonographic findings will provide good support of the physical examination findings and can sometimes provide objective information that the practitioner can monitor over time to determine response to therapy.

References