

Neonatal and pediatric ultrasonography-part II

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Introduction

Pediatric patients are commonly presented to the veterinarian because of signs referable to the abdominal cavity. Presenting signs can be due to congenital anomalies, dietary indiscretion, parasitic infestation and infectious disease. Abdominal ultrasound examination is a particularly useful diagnostic tool in the pediatric patient because it is noninvasive and can usually be performed without sedation or anesthesia. Ultrasonography provides valuable clinical information about the peritoneal cavity, great vessels, abdominal viscera and lymph nodes and thus greatly facilitates diagnostic differentiation between congenital and acquired disorders.¹ Ultrasonographic techniques will be described in this paper.

Keywords: Ultrasound, neonatal, congenital, acquired, pediatric

Disorders of urogenital development

In the past, veterinary pediatric ultrasonography has been hampered by the small size of neonatal organs. Recent advances in pediatric veterinary ultrasonography are encouraging. Abdominal ultrasound can facilitate the diagnosis of congenital urogenital disorders because ectopic, distended ureters and changes in renal architecture are usually readily imaged.² The presence and location of cryptorchid testes can often be detected with ultrasound.¹ Ultrasonographic examination of the bladder disclosing urolithiasis can provide information

suggesting congenital hepatic vascular anomalies. Ammonium biurate urolithiasis is suggestive of hyperammonemia, common with portosystemic shunt disorders (described below).^{3,4}

The most common familial disorders in cats and dogs include renal agenesis, renal dysplasia, polycystic kidneys, renal amyloidosis, basement membrane disorders, and tubular dysfunction (Fanconi's syndrome).⁵

Renal agenesis

Congenital renal agenesis resulting in the absence of a kidney can be confirmed with ultrasound. The contralateral kidney typically has normal internal anatomy, but is enlarged as a consequence of obligatory hypertrophy. Renal function of the pediatric patient does not equate that of the adult until 4-6 months of age, therefore compensatory renomegaly may not be apparent until that time.³

Renal dysplasia

Until reliable genetic markers are marketed and thus available for the various breed specific congenital renal dysplasias (i.e. Persian cats), ultrasound provides the best method of screening young dogs and cats for these likely heritable disorders. Early ultrasonographic screening is possible in platycephalic breeds in which morphologic changes are grossly evident (i.e., Cairn Terriers, German Shepherd Dogs).^{3,5} (fig1)

Ectopic ureter

Congenital ectopic placement of a distal ureter into the urethra, vestibule or vagina is usually associated with ureteral dilation with or without renal pelvic dilation. Dilation of the ureter improves the sensitivity of the ultrasound study; however, the diagnosis can be elusive. Visualization of a nonvascular fluid filled structure with a hyperechoic wall passing dorsal to the urinary bladder, or obvious insertion of the structure into the proximal urethra suggest the diagnosis. Visualization of the ureteral jets in the bladder suggests normalcy, however some

ectopic ureters insert initially into the bladder and additionally tunnel distally to terminate in an abnormal site. Visualization of the dilated ureter usually occurs near the urinary bladder. (fig 2) Visualization of the bladder neck and proximal urethra may be obscured by pubic bone, making identification of such termination difficult.^{1,2}

Hydronephrosis can eventually result from an uncorrected ectopic ureter due to flow impedance at the abnormal site of insertion. (fig 3) Urinary tract infection is commonly associated with ectopia, due to accompanying urethral sphincter mechanism anomalies. If not detected and treated, urinary tract infection can progress to pyelonephritis and ureteritis. Infection and its associated inflammation in the tract can further alter the ultrasonographic appearance of the kidneys, bladder, ureters and urethra.¹

Contrast enhanced computed tomography is the most sensitive and specific modality for the diagnosis of ectopia, but, like double contrast radiography, requires anesthesia, making initial evaluation with ultrasound desirable when ectopia is suspected clinically. The condition is thought to be heritable (mode not known), and is more commonly symptomatic in females due to the greater strength of the male urethral sphincter and longer length of the urethra.⁵

Ureterocele

A ureterocele is an uncommon congenital dilation of the ureter near the bladder, appearing as a cystic structure within the bladder lumen or wall. (fig 4) The ureterocele occurs most commonly in association with an ectopic ureter. Diagnosis can be made by scanning the urinary bladder in the transverse plane and watching for strong peristalsis of the adjacent ureter.¹

Patent urachus

The urachus permits the flow of urine from the bladder into the allantoic sac of the fetus, and normally atrophies at birth. A patent urachus in the neonate is characterized clinically by urine dribbling from the umbilicus. The fluid filled urachus can be identified ultrasonographically, extending cranially from the cranioventral bladder wall. If an incompletely patent urachus is present in the neonate, a urachal diverticulum may result, seen as a divot in the apex of the bladder. (fig 5) Urachal diverticula can predispose the bladder to recurrent infection because of abnormal bladder flow in the region, surgical excision can be indicated.¹

Cryptorchidism

Ultrasound identification of cryptorchid testis(es) can confirm cryptorchidism in pediatric patients with bilateral involvement whose neutering status is unknown.

Ultrasonographic localization of undescended testes can assist the surgeon in planning the approach (i.e., inguinal vs. cranial abdominal). A retained testis can be positioned anywhere between the ipsilateral kidney and the scrotum. A systematic evaluation of the region from the caudal renal pole to the inguinal canal can identify an oval, homogeneously echogenic structure with a mildly hyperechoic border representing the parietal and visceral tunics. The epididymis is usually distinctly less echoic than the testicular parenchyma, as in the scrotal testis. The cryptorchid testis will maintain the anatomic structure, the median testes (a hyperechoic slash), and normal testicular echogenicity despite being reduced in size as compared to a scrotal testis.¹ (fig 6)

Ultrasonography is also the procedure of choice to detect undescended testicles in pediatric or adult dogs and cats. Clinical evaluation via serum LH concentration or testosterone stimulation tests can increase support the diagnosis. An ultrasound examination

may also detect nonpalpable scrotal testicular tumors and neoplastic transformation in abdominal testes.¹ (fig 7)

Disorders of digestive system development

Hernia

Congenital peritoneopericardial diaphragmatic hernias occur in both the dog and cat; ultrasonography provides an additional modality for their diagnosis. As with other diaphragmatic hernias, careful evaluation for continuity of the echogenic diaphragm differentiates a true hernia from mirror image artifacts. Evaluation of the pericardial contents can be made from the subcostal (across the liver) or intercostal (using the heart as an acoustic window) approach. Abnormal pericardial contents can include falciform fat, liver, gall bladder and/or intestines. Congenital inguinal and scrotal hernias can similarly be confirmed by ultrasonographic identification of intestines in the subcutaneous space of the affected groin. This can be a dynamic finding. Mesenteric fat may alternatively be entrapped through the hernia.^{1,6} (fig 8)

Congenital hiatal hernias are more difficult to confirm with ultrasound because of the inherent difficulty imaging the gas filled stomach and the intermittent nature of the disorder. Stomach wall with characteristic rugal folds can be imaged crossing the diaphragm into the thoracic cavity. Fluoroscopic evaluation can be more informative in these cases.

A developmental anomaly resulting in extrusion of a portion of the gastrointestinal tract outside of the body wall, occurring within the umbilical canal (omphalocele) or lateral to the umbilical canal (gastroschisis), has been reported in humans and occurs in both dogs and cats. The condition is usually hopeless in small pediatric patients presented to the veterinarian hours after birth; however, a 30-70% survival rate is reported in humans with immediate post partum surgical intervention. Diagnosis is made pre partum with abdominal

ultrasound, based on the recognition of fetal gastric wall (rugae) structures or intestinal contents in an abnormal location. Earlier surgical intervention before inevitable septic contamination occurs may improve the prognosis in veterinary patients.^{1,5}

Enteric anomalies

Pyloric stenosis secondary to hypertrophic gastritis has been reported in a pediatric dog. Focal circumferential thickening of the pylorus primarily involving the muscularis is typical.

Enteric duplication or agenesis can be confirmed ultrasonographically in pediatric patients. Duplication is rare, can occur anywhere in the intestinal tract and the clinical signs may be nonspecific. A fluid filled juxtaintestinal formation with variable peristalsis and contents can be seen. Enteric agenesis usually results in severe clinical signs in the neonatal period. Ultrasonographic findings usually include marked fluid and gas distention of bowel proximal to the defect.⁵

Several breeds of dogs have a reported genetic predilection to small intestinal disease. Normally, the small bowel appears sonographically as four distinct layers. The bowel lumen is hyperechoic, as gas and ingesta are compressed. The layer just outside the lumen is the mucosa; it is hypoechoic and normally the thickest appearing section. Outside the mucosa is the submucosa, it is hyperechoic to the mucosa and about one third the thickness. The muscularis, the bowel muscle layer, is outside of the submucosa and appears as a very thin hypoechoic black line. (fig 9, 10)

An immunoproliferative enteropathy is seen in the Basenji breed which is characterized by lymphangectasia, intermittent diarrhea, weight loss, hypoalbuminemia and hyperglobulinemia, and lymphoplasmacytic mucosal infiltrates throughout the GI tract. Histopathology is diagnostic, however abdominal ultrasonography can identify bowel in which

disruption of the normal layering has occurred. Chinese Sharpei dogs have been identified with a lymphoplasmacytic-eosinophilic infiltrative enteropathy that is characterized by poor weight gain, weight loss, or intermittent diarrhea episodes, with onset of signs typically between 2 to 6 months of age. Infiltrative enteropathies can be characterized ultrasonographically as having changes in the normal bowel wall layering.⁵

Portosystemic shunt

Portosystemic shunts (PSS) are congenital malformations of the hepatic portal venous drainage system and can have either a familial, i.e. genetic, or random occurrence. Congenital PSS can be either intrahepatic or extrahepatic; breed predilections for extrahepatic shunts include Yorkshire terrier, Maltese, Poodle, Miniature Schnauzer, Dachshund, Lhasa Apso, Pekingese, Pug, and Shih Tzu, whereas intrahepatic shunts are more commonly identified in large breed dogs such as Golden Retrievers, German Shepherds, Irish Wolfhounds, Irish Setters, and Samoyeds. PSS are uncommon in cats.

Ultrasonography provides a rapid and noninvasive method for screening patients suspected to have congenital PSS. Although scintigraphy (transcolonic portal scintigraphy or transplenic portography) is considered the most reliable noninvasive method of documenting a PSS, its availability is limited to specialty and university practices, and its use dictates special handling of the radioactive patient for at least 12 hours. Mesenteric portography, although more invasive and requiring general anesthesia, is a highly reliable method of confirming and localizing PSS.^{1,7}

Abdominal ultrasonography is a useful diagnostic tool and is routinely done when a PSS is suspected. (fig 11,12) It is non-invasive and requires no anesthesia however diagnostic accuracy is highly operator dependent, and the PSS will be confirmed in only approximately 60-80% of cases. The liver may be small and difficult to image in patients with

congenital portosystemic shunts. Imaging the liver from the standard ventral approach can be improved in some cases by using the left ventral intercostal and right dorsal intercostal approaches. The presence of ascites can facilitate the study, as can adding fluid to the stomach, and positioning the patient to shift gas away from the scanhead and shift abdominal organs caudally.(fig 13) Ultrasound evaluation of portosystemic anomalies can be facilitated by positive pressure ventilation under anesthesia for the same reason. Cystic calculi, most commonly ammonium biurate, should increase the clinical suspicion of PSS. Urinary bladder calculi (radiolucent and radiopaque) produce a strong acoustic shadow when viewed ultrasonographically.¹ (fig 14)

Post operatively, ultrasound can be used to evaluate portal blood flow following surgical banding or coil embolization. Extrahepatic shunts most commonly arise from the portal vein, splenic vein or left gastric vein in the dog, and from the left gastric vein in the cat. (fig 15) Identification of a shunting vessel emptying into the caudal vena cava is difficult but confirmatory. Intrahepatic shunts can be more difficult to identify because of patient size, bowel gas and liver size. Clipping the hair coat intercostally on the right can allow for transverse vessel stacking (of the aorta, vena cava and portal vein) and allow visualization of ductal shunts. There can be right and left shunting of the ductus.^{1,7}

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