IMAGING ESSENTIALS

Ultrasonography of Peritoneal and Retroperitoneal Spaces and Abdominal Lymph Nodes

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Welcome to our series of articles on small animal abdominal ultrasonography. The initial articles provided an overview of basic ultrasonography principles and a discussion about how to perform a systematic scan of the abdomen. The rest of the series discusses ultrasound evaluation of specific abdominal organs/systems.

Read the other small animal abdominal ultrasonography articles published in *Today's Veterinary Practice* at **tvpjournal.com**.

The peritoneal and retroperitoneal spaces are assessed throughout the ultrasound examination of the entire abdomen. The abdominal lymph nodes (lymphocenters), which are located throughout the abdomen, drain specific regional organs and areas. This article reviews the normal ultrasonographic appearance of these structures in dogs and cats as well as commonly encountered abnormalities.

PERITONEUM AND RETROPERITONEUM

Normal Findings

Ultrasound examination of the peritoneal and retroperitoneal spaces involves evaluation of the falciform, mesenteric, and retroperitoneal fat as well as potential cavities within these areas for the presence of masses, gas, or fluid (**Figure 1**). Like the pleural space, the peritoneal

FIGURE 1. (**A**) Long-axis view of an adult canine liver just to the left of midline. The falciform fat seen in the near field (**ventral; arrow**) is hypoechoic relative to the liver and has a coarse echotexture. (**B**) Long-axis image in the area of the spleen from the same dog. The mesenteric fat (**arrow**) is seen dorsal to the spleen and is hypoechoic relative to the spleen and coarse in echotexture. (**C**) Fat in the retroperitoneal space surrounding the left adrenal gland. The fat is relatively hyperechoic to the left adrenal gland (**LA**) and is coarse in overall echogenicity. The anechoic circle ventral to the midportion of the long axis of the left adrenal gland is the phrenicoabdominal vein (**arrow**). **HM**, hypaxial musculature; **Spl**, spleen.

FIGURE 2. Anechoic focal effusion (**arrow**) from the abdomen of a normal 4-month-old dog. A transudate was identified on cytology.

FIGURE 3. Long-axis image of the cranial abdomen in an adult dog. Note the anechoic effusion separating the diaphragm and the spleen and liver.

space is a closed cavity with a serous mesothelial lining.[1] A scant amount of physiologic peritoneal effusion, typically not seen on ultrasonography, is normal; this effusion serves as a lubricant for the peritoneal organs.

A small amount of anechoic peritoneal effusion can be seen in young puppies and kittens[2] (**Figure 2**), but no effusion should be seen in healthy adult dogs and cats.[3,4] The fat within the peritoneum (located primarily in the mesentery and falciform ligament) has intermediate echogenicity and a coarse echotexture (**Figure 1**).

Effusions

Peritoneal effusions can be detected by the presence of anechoic fluid separating and/or surrounding normal abdominal structures (**Figure 3**). Peritoneal fluid accumulation in adult dogs and cats is considered abnormal. Peritoneal effusion should be evaluated with cytology as well as culture and antibiotic sensitivity testing if sepsis is suspected.

Determining the type of effusion based on its echogenicity is problematic because ultrasound lacks specificity: anechoic effusions can be exudates and echogenic effusions can be transudates (**Figure 4**). Nevertheless, a pure or modified transudate typically appears anechoic with no echogenic foci suspended in the fluid.[3–5] Intraperitoneal hemorrhage, inflammation, or neoplastic effusions typically appear echogenic with suspended echoes.[3–5] With moderate to severe peritoneal effusion, artifacts are more readily apparent. These include refraction artifacts along curved surfaces with urinary bladder wall dropout at the area of refraction, distal acoustic enhancement (through-transmission), or side lobe artifacts (see "**Physical Principles of Artifacts & False Assumptions**" [May/June 2015]).

Focal effusions, compared with generalized effusion, can be seen in areas of focal organ pathology (eg, acute pancreatitis). Additionally, exudative effusions can incite an inflammatory response resulting in increased echogenicity of the surrounding peritoneal or retroperitoneal fat[6] (**Figure 5**). In all cases of significant effusion, the echogenicity of the peritoneal and retroperitoneal fat is increased due to through-transmission or distal acoustic enhancement.

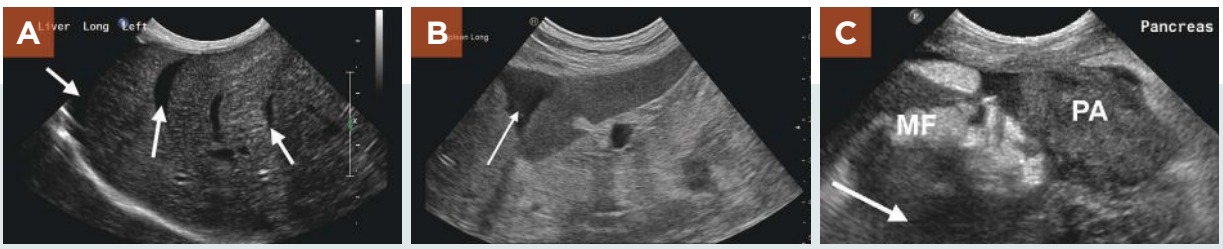

FIGURE 4. Protein-losing enteropathy and hypoalbuminemia causing a pure abdominal transudate in a 12-year-old dog. (**A**) Multiple curvilinear areas of anechoic peritoneal effusion can be seen (**arrows**). (**B**) Echogenic effusion (**arrow**) secondary to hemorrhage from a splenic mass rupture. (**C**) Hyperechoic, hyperattenuating mesenteric fat (**MF**) with distal acoustic dropout due to attenuation (**arrow**) surrounding an inflamed, enlarged, hypoechoic pancreas (**PA**). In addition a mild echogenic effusion is seen surrounding the pancreas.

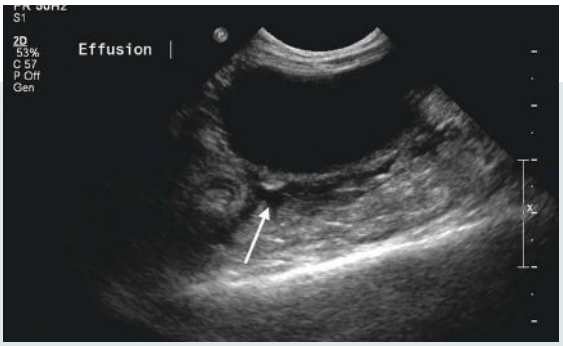

FIGURE 5. Effusion dorsal (far field, **arrow**) to the urinary bladder in a dog with ascites caused by right heart failure.

FIGURE 6. Long-axis ultrasound image of the left kidney from a dog with acute renal failure secondary to leptospirosis. There is a perinephric effusion (**arrow**).

If a small amount of peritoneal effusion is noted, focal collections of fluid may be seen first in the area of the liver (surrounding the hepatic lobes or gallbladder) or at the level of the cranial pole of the urinary bladder in the caudal abdomen (**Figure 4A**). These areas should be scrutinized selectively when a small amount of effusion is suspected.

In cases of inflammatory or neoplastic effusion, the mesenteric fat can become hyperechoic and hyperattenuating, as is seen in small animals with pancreatitis or carcinomatosis (**Figure 4B and 4C**). Acute renal disorders can also result in a perinephric effusion and hyperechoic retroperitoneal fat[7] (**Figure 6**). Neoplasia of the retroperitoneal space has been reported (hemangiosarcoma, undifferentiated carcinoma, extra-adrenal or adrenal pheochromocytoma).[3,4]

Disseminated Abdominal Neoplasia

Peritoneal effusion in cats and dogs may be secondary to carcinomatosis. In cats, the common sites of primary neoplasia resulting in peritoneal invasion and involvement are the pancreas, liver, and intestinal tract.[8] In dogs, sarcomatosis is most commonly secondary to ruptured splenic or hepatic hemangiosarcoma with peritoneal seeding[9] (**Figure 7**).

Pneumoperitoneum

Common causes of pneumoperitoneum include rupture of a hollow viscus (typically gastrointestinal tract) or a penetrating wound. Small-volume pneumoperitoneum can be difficult to identify on ultrasound because the probe must be positioned on top of the free air for the air to be visualized.[10] Characteristic features of a pneumoperitoneum include gas and associated artifacts outside the gastrointestinal tract (**Figure 8**).

Nodular Fat Necrosis

Nodular fat necrosis is an incidental finding in cats (primarily) and dogs that appears as an oval structure within the peritoneal space. Such structures are mineralized and therefore have a curvilinear hyperechoic boundary and distal acoustic shadowing.[11] They usually appear singly and can be found anywhere in the peritoneal (and, to a lesser extent, pleural) cavity (**Figure 9**).

ABDOMINAL LYMPH NODES (LYMPHOCENTERS)

Abdominal lymph nodes can be divided into the parietal nodes (periaortic, renal, medial iliac, internal

FIGURE 7. Diffuse peritoneal nodules from 3 different animals. (**A**) A cat with carcinomatosis due to pancreatic adenocarcinoma. Multiple hypoechoic nodules are noted throughout the mesentery. (**B**) A dog with sarcomatosis secondary to peritoneal spread of hemangiosarcoma after rupture of a splenic hemangiosarcoma. Multiple hypoechoic nodules were noted adjacent to the jejunum within the mesentery (**arrow**). (**C**) A dog with lymphomatosis secondary to multicentric lymphoma. The heteroechoic to hypoechoic nodules (**arrows**) were within the mesentery and separate from the mesenteric lymph nodes that were also enlarged.

iliac, and sacral) and visceral nodes (hepatic, splenic, gastric, pancreaticoduodenal, jejunal, ileocolic, and colic).[3,4] A number of abdominal lymph nodes are not routinely seen on ultrasonography.

Abdominal lymph nodes vary dramatically in size and shape depending on the age of the animal and the location of the node.[12] Assessment of abdominal lymph nodes requires the sonographer to understand the normal anatomic location of the individual nodes as well as the regional anatomy, particularly the vascular anatomy, because lymph nodes are found surrounding specific abdominal vessels.[6,13–16]

Parietal Nodes

The medial iliac lymph nodes are found caudal to the deep circumflex arteries along the lateral margins of the origins of the left and right external iliac arteries from the aorta (aortic trifurcation). These nodes are located immediately cranial to, at, or just caudal to the trifurcation of the caudal abdominal aorta.[16] They can be dorsolateral, lateral, or ventrolateral to the caudal abdominal vasculature.

To identify medial iliac lymph nodes, therefore, it is necessary to sweep the transducer in a dorsoventral direction while imaging the vessels in long axis. Translation motion in the transverse plane while imaging the caudal aorta at the level of the trifurcation is also very useful to identify these nodes, often using a paralumbar acoustic window.

In larger dogs, the medial iliac lymph nodes are typically 2 to 4 cm in length. They can be seen as fusiform to oval in shape and are isoechoic to slightly hypoechoic (relative to the surrounding fat) with a faint outer hyperechoic capsule. These nodes can be evaluated in long-axis (sagittal) or short-axis (transverse) view (**Figure 10**) and are usually 3 to 5 mm in thickness in the adult dog.[2] The medial iliac lymph nodes receive afferent lymphatics that drain the caudal abdomen, pelvis, tail, and pelvic limbs. Features of malignancy that have been described include enlarged, round, hypoechoic to anechoic internal echogenicity with little echotexture.[17] In addition, focal effusion or hyperechoic fat may surround the abnormal lymph node in dogs.[17]

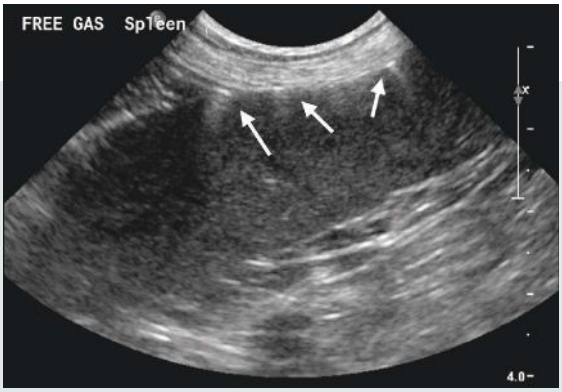

FIGURE 8. Static ultrasound image from a dog with a pneumoperitoneum (**arrows**) with focal reverberation artifacts secondary to soft tissue-gas interface. This pneumoperitoneum was secondary to duodenal ulcer perforation from nonsteroidal anti-inflammatory drug administration.

FIGURE 9. A focal hyperechoic nodule with distal acoustic shadowing from a focal area of nodular fat necrosis with resultant dystrophic mineralization (**arrow**).

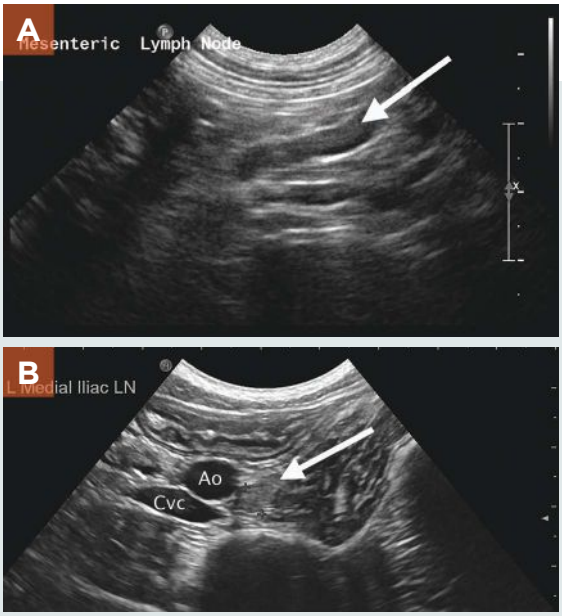

FIGURE 10. (**A**) Long-axis image of a normal mesenteric lymph node (**arrow**) from a dog with a normal abdominal ultrasound and no clinical signs. (**B**) Short-axis image of the medial iliac lymph node (**arrow**) in the same dog. The node is highlighted (+) to show the normal width. **Ao**, aorta, **Cvc**, caudal vena cava.

PEER REVIEWED

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The internal iliac (formerly "hypogastric") and sacral lymph nodes are found between the origin of the external and internal iliac arteries and alongside the median sacral artery, respectively. These lymph nodes receive afferent lymphatics from the rectum, pelvic canal, anal glands, and perineal region. Although these nodes are not routinely identified, this area should be evaluated as metastases from tumors in these regions do occur with enlargement of these specific lymph nodes, and the internal iliac lymph nodes may then be appreciated.[18,19]

Unless severely enlarged, the sacral lymph nodes are typically not visible ultrasonographically due to their position in the pelvic canal. They are obscured by the shadow from the pubic bones.

Visceral Nodes

The jejunal or mesenteric lymph nodes are the largest lymph nodes in the abdomen. They are located around the cranial mesenteric artery and vein in the right cranial to middle abdomen just to the right of the umbilicus (**Figure 11**). These lymph nodes are vermiform, cylindrical, and elongated and measure up to 0.5 cm thick and up to 3 to 4 cm long.[20]

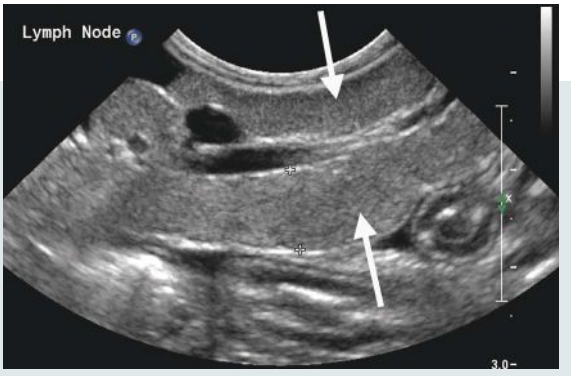

FIGURE 11. Mildly enlarged (10 mm) mesenteric lymph nodes (**arrows**) from a 4-month-old dog. This degree of mild lymphadenomegaly is normal in puppies.

Contrast ultrasonography has been described to better characterize lymph node enlargement patterns.[21]

The jejunal lymph nodes are usually reactive and enlarged in young dogs and cats up to 1 year of age (**Figure 11**).[3,4,13] They can be heteroechoic with multiple peripheral hypoechoic nodules. The jejunal or mesenteric lymph nodes are commonly enlarged in inflammatory (eg, secondary to inflammatory bowel disease), infectious (eg, pythiosis), and neoplastic (eg, metastatic disease from adenocarcinoma or involvement in multicentric round cell neoplasia; **Figures 12 and 13**) disorders of the gastrointestinal tract.

The appearance of the cisterni chyli has been reported as an anechoic tubular structure, without detectable flow, at the right dorsolateral aspect of the aorta at the level of the cranial mesenteric artery. The shape and size of the cisterna chyli in an individual dog can vary during the same ultrasound examination and between different examinations.[22]

SUMMARY

As in all cases of abdominal disease, increases or decreases in overall echogenicity are subjective, and sonographers must be familiar with how the peritoneal and retroperitoneal spaces and abdominal lymph nodes appear in normal dogs and cats when scanned with their machines. Severe enlargement of abdominal lymph nodes is usually an indicator of neoplasia (multicentric or metastatic); however, mild to moderate enlargement can indicate either neoplasia or reactive lymphadenopathy secondary to inflammation or infection. TVP

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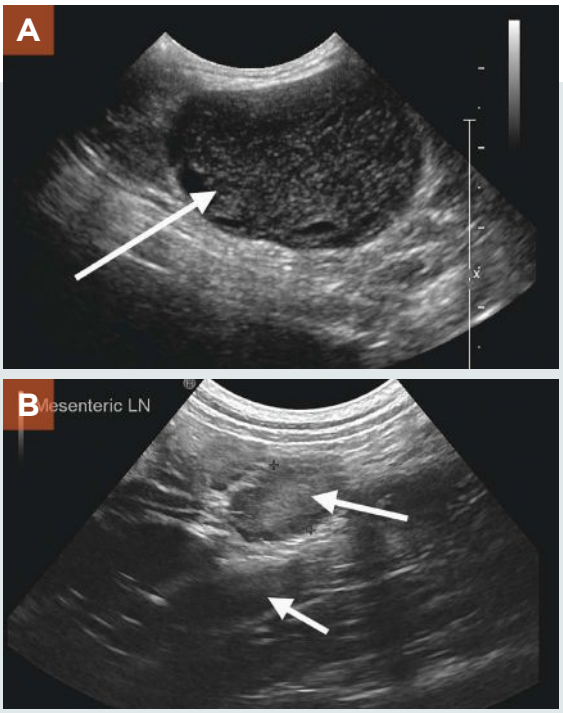

FIGURE 12. Enlarged, oval, hypoechoic lymph nodes from 2 dogs with abdominal pathology. (**A**) Internal iliac lymph node (**arrow**) in a dog with lymphoma. (**B**) Mesenteric lymph node (**arrows**) in a dog with histiocytic sarcoma.

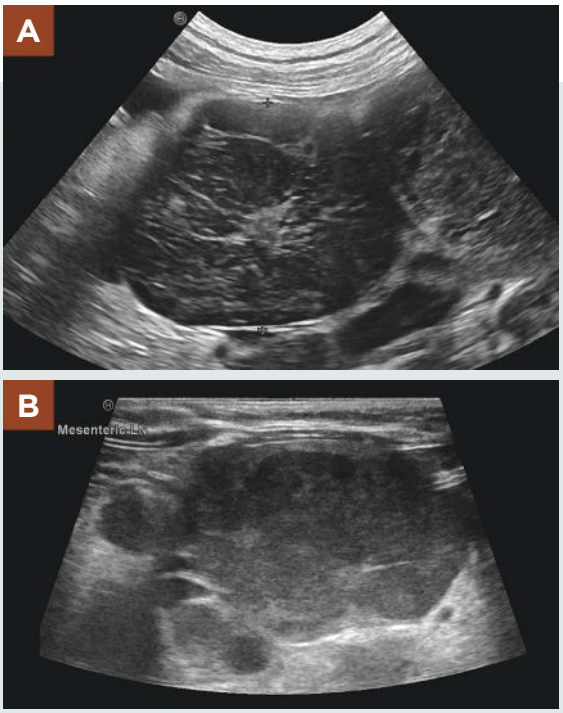

FIGURE 13. (**A**) Enlarged mesenteric (jejunal) lymph nodes in a cat with large B-cell lymphoma. (**B**) Enlarged mesenteric lymph nodes with surrounding echogenic mesentery from a dog with duodenal and gastric masses secondary to a *Pythium* infection.

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