CT IMAGING OF THE ACUTE ABDOMEN

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‘Acute abdomen’ is a term frequently used to describe the acute abdominal pain in a subgroup of animals who are severely ill and have abdominal tenderness and rigidity. Acute abdominal pain is a common chief complaint in dogs and cats presenting to emergency and can be related to a myriad of diagnoses. Obtaining a careful medical history and performing a physical examination are the initial diagnostic steps for these patients. On the basis of the results of this clinical evaluation and laboratory investigations, the clinician will consider imaging examinations to help establish the correct diagnosis. Although in people the use of CT in the evaluation of acute abdominal pain has increased to a large extent, it is not as commonly used in that indication in veterinary medicine, where radiography and ultrasound are usually the first imaging tests performed.

COMPARATIVE IMAGING
Survey radiography and routine abdominal ultrasound are the conventional imaging techniques used in dogs and cats with acute abdominal signs but have multiple limitations. With the exception of the identification of spontaneous pneumoperitoneum, survey radiographic findings are often nonspecific. As a result, abdominal ultrasound is often performed in addition to radiographs, with the advantages including elimination of visceral superimposition and ability to evaluate parenchymal detail. However, ultrasound can be challenging in dogs and cats with severe abdominal pain, and there are significant limitations due to poor image quality in larger animals or when there is significant gas interposition (e.g. significant pneumoperitoneum, severe aerophagia, etc.). With the advent of multidetector CT scanners, rapid scanning can be achieved making CT a more approachable imaging modality in these critical patients. With faster scanning, diagnostic images can be obtained in awake patients or with the use of light sedation (e.g. opioid with or without benzodiazepine administered intravenously as a bolus or continuous rate infusion). Dedicated patient devices (e.g. Vetmousestrap™) facilitate positioning and immobilization of the patient during scanning. Sensitivity of CT is superior to ultrasound for the detection of critical findings such as small volume pneumoperitoneum which may warrant emergency surgical exploration. A recent comparative study showed a slightly higher diagnostic accuracy when using sedated CT alone in dogs with acute abdominal signs compared with radiographs alone or ultrasound alone. CT performed better at identifying small volume pneumoperitoneum while ultrasound slightly outperformed CT at identifying small volume peritoneal effusion. Overall it was also shown that CT has an advantage in lesion detection in dogs greater than 25 kg, making it a better screening test for abdominal disease in these patients.

FAT STRANDING
The CT feature of fat stranding, defined as an abnormal increased attenuation in mesenteric fat, is caused by increased edema and engorgement of local lymphatics and its identification at CT should call attention to the regional organs as being the potential source of the acute clinical presentation. This CT finding may manifest with multiple patterns including a subtle hazy/ground-glass like appearance in the presence of mild inflammation or a more reticular pattern with more well-defined linear areas of increased attenuation (‘lacy pattern’) with more severe inflammatory conditions. A reticulonodular pattern may also be observed in association with neoplastic disease. This CT feature is identified across a broad spectrum of disease processes including, but not limited to, disease originating from the intestine, pancreas, gallbladder, and upper urinary tract.

PANCREATITIS
CT is rarely used for diagnosis of pancreatitis however has been reported to provide additional information compared to ultrasonography such as areas of concurrent vascular thrombosis that may remain undetected with ultrasound. Signs of pancreatitis at CT are similar to those seen on ultrasound including pancreatic enlargement and hyperattenuating peripancreatic fat with a lacy pattern and effusion. The entire pancreas is readily evaluated at CT while significant portions of the gland may not be imaged with ultrasound due to gas interposition and patient discomfort. At CT, necrotizing pancreatitis causes areas of pancreatic thickening that are hypoattenuating compared to normal pancreas and have no enhancement after iodine injection. Heterogeneous contrast enhancement of the pancreas at CT may be a negative prognostic indicator.

INTESTINAL OBSTRUCTION
Initial comparative studies have shown that CT may have slightly higher sensitivity and specificity than plain radiography for the identification of mechanical obstruction in dogs when interpreted by radiologists. Compared to ultrasonography, CT is much faster and may have higher accuracy for diagnosis of intestinal obstruction in dogs. CT may also help characterizing the cause for obstruction better than ultrasound. For example, entero-parietal adhesions from previous surgery can be identified through disruption of the ‘properitoneal fat line’ coupled with close association of the adhered small intestine and focal intestinal dilation orad to the site of adhesion.

GASTROINTESTINAL RUPTURE
Gastrointestinal rupture is a common cause for acute abdominal syndrome in dogs and cats. Causes include rupture of a GI neoplasm, rupture ulcer or perforating foreign body. The hallmark of this condition at CT is the presence of free peritoneal gas. CT may be more sensitive than ultrasound in the detection of small amount of free peritoneal gas. Identification of the origin of the rupture is usually straightforward at CT as there will usually be marked focal fat stranding at that site. Adhesions of intestinal loops to the site may be present in more chronic cases and can be recognized through the abnormal curving pattern of the intestinal loops, which may appear clustered around the rupture site or making angular geometric turns. Gastrointestinal masses are readily recognized as focal mass-like thickening of the affected gastrointestinal segment, with variable degrees of contrast-enhancement. Effusion due to peritonitis may be present depending on duration of the rupture at the time of imaging. Foreign bodies will usually be readily identified in the lumen of the affected loop due to their abnormal attenuation pattern or geometric shape.

SPLENIC AND MESENTERIC TORSION
CT diagnosis of splenic torsion is pretty straightforward. Enlargement and abnormal position/orientation of the spleen is seen with lack of parenchymal enhancement on post-contrast images. The ‘whirlpool sign’, also known as the ‘whirl sign’, is seen when a structure twists upon itself and is typically seen at the pedicle of the spleen especially on post-contrast images where the vessels assume a spiraling pattern. In cases of mesenteric volvulus, the whirl sign is also seen appearing as small bowel loops encircling the cranial mesenteric artery. The “whirl” consists of concentric intestinal loops, blood vessels, and fat. Additional signs include segmental or global dilation of the small intestine, intestinal wall thickening, congestion of the mesenteric veins with or without thrombosis, abnormal position and orientation of the cranial mesenteric artery, a ‘beak’ shape of the intestine at the point of torsion and peritoneal effusion.

MESENTERIC ISCHEMIA
Aside from vascular pedicle torsion, described above, mesenteric ischemia may result from thrombosis. It has rarely been reported in dogs and cats. CT angiography at the arterial phase allows identification of arterial filling defects corresponding to the clots. Additional signs include segmental dilation of the intestinal loops (ileus), intestinal wall pneumatosis and portal venous gas. The wall of the affected intestine may be thickened (edema/hemorrhage) or (in case or pure arterial thrombosis) thinner due to loss of blood supply and muscular tone.

BILIARY DISORDERS
Biliary disorders causing acute abdominal signs include cholecystitis and gallbladder wall necrosis. Cholecystitis causes marked thickening and contrast enhancement of the gallbladder wall. Gas in the wall and lumen of the gallbladder may be seen in cases of emphysematous cholecystitis. Gallbladder wall
necrosis may be characterized by lack of contrast enhancement of portions of the wall with possible thinning. The appearance of gallbladder mucocele at CT has not been reported yet.

**ABSCESSES**

Abscesses can be seen in parenchymal organs such as the liver, spleen, kidneys, prostate. Abscesses of the intestinal wall may also be encountered secondary to wall trauma by foreign material for example. At CT, abscesses present as cavitary lesions with fluid-attenuating center and intensely contrast-enhancing wall (rim-enhancing pattern). The presence of cavitary gas and possibly concurrent free peritoneal gas is key in the diagnosis of abscesses at CT; in the absence of gas, sampling for cytology may be necessary for a definitive differentiation with solid rim-enhancing lesions.

**REFERENCES**