CT and MRI for Advanced Practitioners Mini Series

Session Three: CT of the thorax and abdomen

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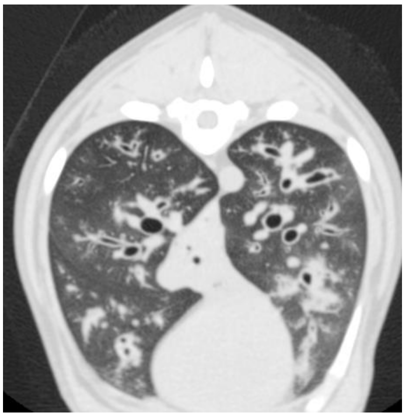

CT of the thorax

Introduction

Radiography is the more commonly used diagnostic imaging modality to evaluate the thorax in veterinary patients. It offers good visualization of different intrathoracic structures and is particularly useful for the evaluation of pulmonary pathology. Nevertheless, a more complete assessment of the lung and the other surrounding thoracic structures may be obtained by use of alternative imaging techniques such as computed tomography (CT). CT has several advantages over survey radiography to image the thorax including elimination of superimposed anatomy and superior contrast resolution. These properties allow clarification of intrathoracic lesions when radiographic findings are negative or nonspecific.

Penetrating thoracic wall injuries

Penetrating thoracic wall injuries from bite wounds or foreign bodies are common and usually manifest with pleural or pulmonary clinical signs. Thoracic imaging is always indicated in these cases and usually identifies a combination of abnormalities including pleural effusion, subcutaneous emphysema, pneumothorax, pneumomediastinum, rib fractures and lung injuries. Thoracic radiography does not provide adequate information regarding the extension of the lesions or the presence of foreign material. Computed tomography is therefore indicated to access the extension of the body wall damage, presence of foreign material and surgical planning.

Lung lobe torsion

Lung lobe torsion is characterized by axial rotation of a lung around its bronchus leading to bronchial and pulmonary vein obstruction. Arterial inflow, especially from the bronchial arterial system, is not obstructed completely, leading to congestion and consolidation as fluid moves into the interstitium, airways, and possibly into the pleural cavity. Torsion of the right middle lobe is more common in large dogs, whereas left cranial lobe torsion is more common in small dogs. Of small-breed dogs with lung lobe torsion, pugs appear to be overrepresented. The radiographic diagnosis of lung lobe torsion is not obvious in every patient, and CT will be needed for confirmation in some.

CT features of lung lobe torsion includes pleural effusion and abrupt termination of the affected lung lobe bronchus. Additional findings are lobar enlargement, peripheral parenchymal collapse/consolidation, and central vesicular emphysema. Emphysematous lobes have mild or absent enhancement following intravenous contrast administration because of torsional vascular occlusion and necrosis. Lung lobes that have undergone torsion and are small in size are less affected by necrosis, possibly due to hyperacute or chronic time course or partial torsion. These atelectatic lobes are contrast enhancing as they retain blood supply. Partial lobar torsion can occasionally occur and is more challenging to diagnose since characteristic features associated with complete torsion may be absent.

Chronic bronchitis

Canine chronic bronchitis typically affects middle-aged and older dogs with chronic airway inflammation, smooth muscle hypertrophy and mucous gland hyperplasia. Potential causes of canine bronchitis include infectious, inflammatory or allergic disease, dynamic airway collapse and bronchiectasis. The diagnosis of chronic bronchitis relies on exclusion of other causes of chronic cough through results of thoracic radiography, bronchoscopy, cytologic analysis and bacterial culture of BAL fluid samples, hematologic analysis, arterial blood gas analysis, pulmonary function tests, and faecal examination for respiratory parasites.

The radiographic or CT diagnosis of chronic bronchitis relies on identification of a bronchial pattern, demonstrated by a greater than typical number of visible bronchial walls or conspicuity of the bronchial walls. Radiography is a relatively inexpensive and non-invasive technique for assessment of the pulmonary parenchyma and, unlike bronchoscopy, can be performed on unanesthetized dogs.

CT offers little advantage over thoracic radiography in the diagnosis of chronic bronchitis in dogs. and unremarkable thoracic CT findings do not rule out this condition in dogs with a persistent cough.

Pulmonary thromboembolism

Pulmonary thromboembolism is often seen as a sequela of a hypercoagulable state or in patients with inflammatory pulmonary vascular disorders, such as heartworm disease. CT angiography is the imaging study of choice for diagnosis of pulmonary thromboembolism. In the acute phase, blood clots are rarely seen on pre-contrast CT images but are clearly seen as well-defined filling defects on contrast-enhanced images, with arterial enlargement sometimes present proximal to the site of obstruction and an abrupt termination of the enhancing vessel distally with complete obstruction. Partial obstruction results in eccentric filling defects. (Fig. 1)

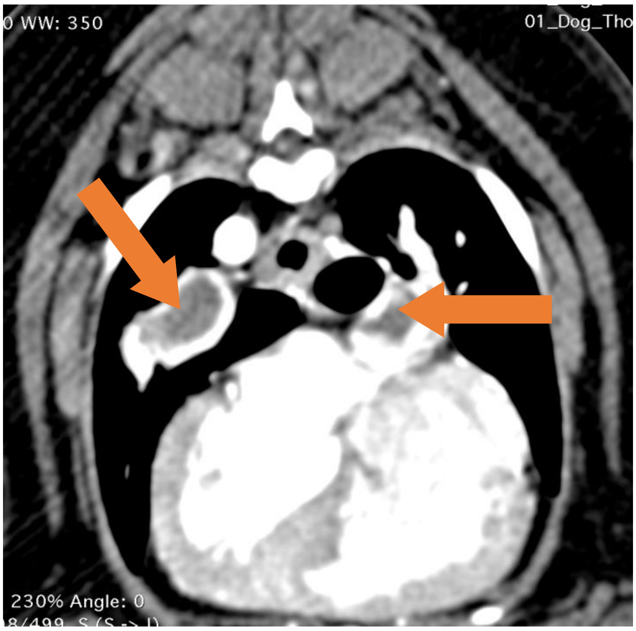

Fig. 1

Widespread or large artery thromboembolism can result in right ventricular failure with associated distension of the right ventricle, vena cava, and hepatic veins. Small artery embolism may result in focal pulmonary infarction in the periphery of the lung. These often have a wedge shape corresponding to the geographic perfusion distribution of the affected vessel.

CT features of chronic pulmonary thromboembolism is characterized by filling defects on contrast enhanced images. Chronic thrombi are approximately 90 HU, so they will appear hyperattenuating compared to patent vessels on unenhanced CT images. Affected vessels are of smaller diameter than unaffected vessels. Development of collateral bronchial circulation may occur with chronic disease. Pulmonary arterial hypertension leads to main pulmonary artery enlargement and mosaic perfusion pattern (low-attenuation areas due to oligemia).

<u>Pulmonary nodules and masses</u>

When a lung nodule or mass is identified, the tendency is to consider it malignant, but it is critical to realize that inflammation can also lead to the formation of lung nodules or masses. The detection of lung nodules or masses should be interpreted in the context of the signalment and history, and a definitive diagnosis should never be made on the basis of the radiographic or tomographic appearance alone. Although neoplastic infiltration is the most common cause, pulmonary nodules and masses may be present in dogs with other pathologies such eosinophilic bronchopneumonia (Mesquita et al., 2015). These dogs usually have a wide variety of computed tomographic features including pulmonary parenchymal abnormalities, bronchial wall thickening, plugging of the bronchial lumen by mucus/debris, bronchiectasis and lymphadenopathy (Fig. 2).

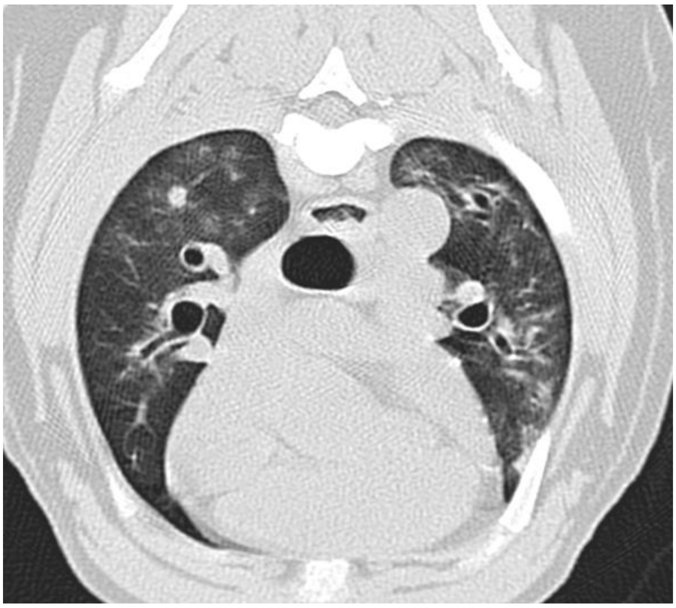

Fig. 2

Differential diagnoses for pulmonary nodules or masses include primary or secondary neoplasia, lymphoma, granuloma, abscess or haematoma.

A soft tissue nodule in the lung must reach some critical diameter before it is large enough to be visible radiographically. This relates to the nodule being large enough to absorb enough x-rays and become conspicuous when superimposed on the heterogeneous background opacity of the lung. The absolute value of this critical diameter will be influenced by the location of the nodule within the lung, relating to whether it is superimposed on other structures, and also to the quality of the radiographic image.

In humans with CT confirmed lung nodules, the detection rate for lung nodules ranging in diameter from 5.4 to 8.0 mm was only 26% in digital radiographs. The existence of a size threshold before pulmonary nodules become radiographically conspicuous means that failure to detect a lung nodule is not evidence that pulmonary nodules are not present. This has been proven in dogs with pulmonary metastasis, and a diameter threshold of 7 to 9 mm for radiographic detection has been suggested. The distinction between a lung mass and a lung nodule is strictly a matter of size, and this is subjective. As a general rule, a lesion with a diameter less than approximately 2.0 cm can be referred to as a nodule, and larger lesions can be referred to as a mass.

Computed tomography has been shown to be more sensitive than radiography for pulmonary metastasis detection. In one study, only about 10% of nodules seen on CT studies were detected on radiographs, with nodules less than about 8 mm most frequently missed. Due to the high sensitivity of CT, very small pulmonary nodules are frequently visible in dogs and cats, and not all of them are neoplastic. Ditzels is the medical term used to describe small lung nodules with unknown potential for malignancy in humans. The following guidelines were proposed to access these small lung nodules with unknown potential for malignancy in veterinary patients (adapted from Schwarz T - Veterinary computed tomography)

- 1–2mm in size, very dense lesions throughout the lungs in dogs are most likely incidental pulmonary osteomas. Due to partial volume effect, densitometry is not reliable to confirm mineralization.
- Metastatic disease is more likely to be present with an identified primary tumour with high metastatic potential. The more chronic the primary tumour is, the more likely it is the patient would have advanced metastatic disease, with nodules of a range of sizes.
- In areas of endemic fungal disease with known likelihood for nodule formation, such as histoplasmosis, fungal origin should be considered more likely.
- A follow-up CT scan in 4–6 weeks should be considered.

Cranial mediastinal Masses

Cranial mediastinal masses are common, and the specific aetiology is rarely determined radiographically or topographically. The most common cranial mediastinal masses are lymphoma and thymomas. Other neoplastic masses occasionally found in the cranial mediastinum includes heart base tumours, ectopic thyroid carcinoma, sarcomas and mesothelioma. Non-neoplastic masses such as granulomas, cysts or abscesses may rarely be found.

Computed tomography is usually non-specific therefore fine needle aspirate or biopsy is necessary for the final diagnosis. Pleural effusion is frequently present in patients with a mediastinal mass making the radiographic diagnosis of cranial mediastinal masses challenging. Due to its tomographic nature and ability to differentiate soft fluid from soft tissue, CT is superior to radiography in the diagnosis of cranial mediastinal masses. Another important advantage of CT over radiography for imaging of cranial mediastinal neoplasms is to determine the presence and extent of vascular invasion, which can determine operability and prognosis. With CT imaging, vascular luminal defects representing local tumour extension are best seen on images acquired shortly after contrast administration while intravascular contrast medium concentration is high. However, if images are acquired too quickly, intravascular contrast concentration may be nonuniform because of inadequate recirculation, which can create pseudo-filling defects. Intraluminal tumours appear as relatively hypoattenuating masses surrounded by hyperattenuating blood (Fig. 3). Filling defects can also result from tumour-associated thrombi, which usually cannot be distinguished from tumour invasion.

Fig. 3

Thymomas are variable in size but can be quite large, occupying a significant volume in the cranial thorax and causing cranial lung lobe displacement and atelectasis as well as displacement of the heart, mediastinal blood vessels, and the cranial thoracic oesophagus and trachea. Because of the orientation of the ventral recess of the cranial mediastinum, which is often positioned to the left of midline, large thymomas often extend caudally primarily along the left hemithorax. Thymomas can have a cystic centre with a thick and internally irregular parenchymal margin on CT images, and solid components have a moderate to intense heterogeneous pattern of contrast enhancement. Thymomas can also be associated with development of megaoesophagus in some patients.

Lymphoma in the mediastinum may involve the thymus or the mediastinal lymph nodes, the latter often resulting in marked nodal enlargement with affected lymph nodes retaining their normal shape. Lymph nodes are normally soft-tissue attenuating on unenhanced CT images and may have a uniform or mildly heterogeneous pattern of moderate contrast enhancement (Fig. 4).

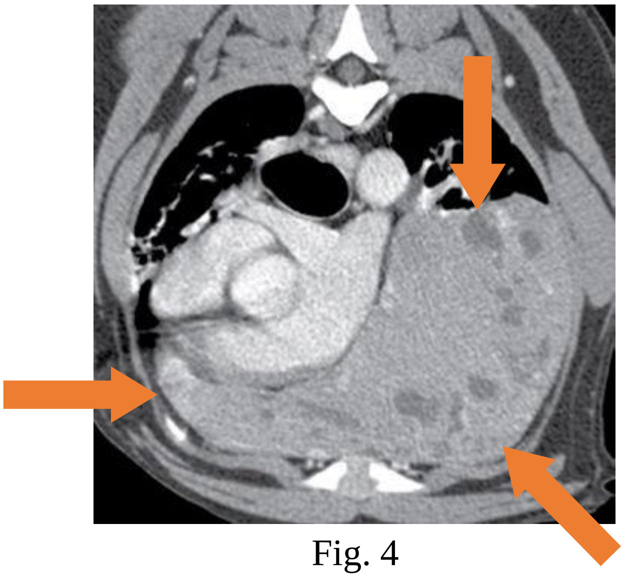

Fig. 4

CT of the abdomen

<u>Introduction</u>

Abdominal ultrasound (US) is commonly performed as a screening test for a variety of abdominal diseases. Ultrasound examination can be time-consuming, and its clinical utility is dependent on the operator's skill. In addition, patient factors, such as body size, presence of gas in the gastrointestinal tract and amount of intraperitoneal fat, can affect the quality of images acquired. For these reasons, abdominal CT have value as a screening test. A historical disadvantage of CT is the need for anaesthesia to prevent voluntary and involuntary motion. With the advent of multidetector helical CT, however, rapid examinations are possible, opening the possibility of screening examinations performed under sedation. The Table1 shows a summary of the advantages and disadvantages of CT and US for abdominal imaging:

US		Computed Tomography
No	Ionizing radiation	Yes
Readily accessible	Availability	Less accessible
Yes	Patient restrain	Yes
Longer	Duration of the study	Short
Yes	Operator dependency	No
Yes	Patient dependency	No
Yes	Biopsies	Yes
Yes	Evidence in veterinary medicine	Yes
Lower	Cost	Higher

Table 1

In a study (Fields et al. 2012), CT detected more abdominal lesions than with US, including clinically relevant lesions, in sedated dogs with more than 25kg. In dogs weighing less than 25kg there was no significant difference. Therefore, abdominal CT should be considered as an initial screening test for abdominal disease in large dogs.

Acute abdomen

Diagnostic imaging plays a pivotal role in the initial assessment of dogs with acute abdominal signs. The ability to obtain a rapid and accurate diagnosis is paramount in guiding appropriate medical and or surgical intervention. Survey radiography and abdominal ultrasonography are the current standard imaging modalities for evaluation of dogs with acute abdominal signs.

A study compared the accuracy of CT, US and radiography for differentiation of surgical vs non-surgical abdominal conditions (Shanaman et al. 2013). In this study, CT had an accuracy of 100% in differentiating surgical vs non-surgical abdominal conditions. The accuracy of US or survey radiography was 94%. This study also found a moderate agreement between the diagnostic imaging modalities with excepting for the presence of pneumoperitoneum. A more recent study (Drost et al. 2016) found no statistical difference between CT and radiography for detecting the presence of mechanical intestinal obstruction. This suggests that all the imaging modalities (US, survey radiography and CT) perform well in canine patients with acute abdominal signs. However, in my experience CT is less reliable than US in the detection of gallbladder mucoceles.

Abdominal trauma

The primary objective in abdominal trauma patients is the identification of life-threatening conditions that may require immediate attention. Therefore, abdominal imaging should only be performed following patient stabilization.

If suspected spinal trauma, minimal and careful handling is fundamental because may aggravate spinal cord injury. This is particularly important in sedated and anaesthetised patients because sedation and anaesthesia cause reduction of muscular bracing. In these cases, the patient should be transported on a rigid, radiolucent board to avoid unnecessary manipulation.

In abdominal trauma patients it is key to access the diaphragmatic integrity, possibility of vertebral fractures, presence of free abdominal fluid and gas and presence of pleural effusion and pneumothorax. It is important to remember that the presence of free abdominal fluid can be investigated with radiography, US or CT however none of the modalities is capable to identify the origin of the fluid (i.e. haemoabdomen, uroabdomen etc). Therefore, collection of fluid for analyses, usually preformed US guided, is necessary to determine the nature of the fluid.

Congenital portosystemic shunts

To diagnose hepatic vascular abnormalities is important to have a good knowledge of the liver vascularization. The normal hepatic arterial vasculature consists of three to five arterial branches that course ventral to the portal vein and parallel the portal branches within the hepatic parenchyma. The caudal vena cava receives short right veins from the right liver lobes, a large left vein from the left liver lobes, and a slightly smaller vein from the right medial and quadrate lobes. The phrenic vein courses parallel to the diaphragm and enters the left hepatic vein at its most cranial aspect. The portal tributaries include the jejunal veins collecting into the cranial mesenteric vein, the colic vein, the splenic vein from the left side, and the gastroduodenal vein from the right and ventral aspect. The portal vein diameter increases with the addition of each tributary. The portal vein then branches to the right lateral liver lobe, and two larger cranial branches supply the right medial lobe and left liver lobes. The left gastric vein joins the splenic vein from the cranial direction and is often involved in anomalous vessels.

Congenital portosystemic shunts (PSS) are abnormal connections of the portal system with the systemic circulation through the CVC or azygos vein. Ultrasonography is the traditional method to identify portosystemic shunts in dogs and cats however this can be sometimes difficult due to the presence of gas in the GI tract and the presence of microhepatica. The identification of an abnormal shunting vessel is the most reliable indication of portosystemic shunt, but other changes, including a small liver that is uniform, decreased or absent intrahepatic portal vasculature, decreased size of extrahepatic portal veins, enlarged kidneys, and renal/ureteral/cystic and/or urethral calculi (urate calculi), are often present.

With the advent of multislice CT angiography protocols, cross-sectional imaging has become a gold standard diagnostic technique for hepatovascular anomalies. Congenital intrahepatic and extrahepatic portosystemic shunts are well seen, and their complex anatomy can be characterized using 3D renderings. This is advantageous for surgical planning and for detecting vasculature that courses through solid organs or crosses the diaphragm. Ultrasonography is a sensitive and specific diagnostic imaging modality to identify the presence of PSS (D'Anjou et al. 2004) but the termination and configuration of the PSS is more often determined with CT than ultrasound.

Congenital intrahepatic PSS occur in large-breed dogs (Irish Wolfhounds, Golden Retrievers, Labrador Retrievers, Australian Cattle Dogs, Old English Sheepdogs) and rarely in cats, resulting in a large-diameter direct communication with the caudal vena cava. These vessels may be classified as left divisional, as a remnant of the ductus venosus; central divisional, coursing relatively straight through the central liver; or right divisional, coursing through the right liver lobes. The majority of intrahepatic shunts in cats are left divisional. CT is capable to demonstrate the anatomy of the abnormal vessel and helps with surgical planning for both open or minimally invasive surgical procedures. Key findings include the anatomic path and termination of the shunt into the caudal vena cava and whether it intersects with large hepatic veins that might be occluded during surgery. The shape and size of the opening of the vessel into the caudal vena cava is also of importance when planning minimally invasive procedures. Caudal vena cava diameter is measured to determine the size of the stent required for shunt attenuation with coils. Multiple intrahepatic shunts can also occur, either as a variant of the primary disorder or as an acquired consequence of attempted shunt attenuation. These are small diameter, irregular branches that connect to the hepatic veins and may mimic hepatic veins themselves.

Congenital extrahepatic shunts occur in smaller-breed dogs (Cairn Terriers, Yorkshire Terriers, Russell Terriers, Dachshunds, Miniature Schnauzers, Maltese) and cats. The majority of shunts are single; however, multiple congenital extrahepatic shunts are occasionally seen. Extrahepatic shunts have been classified as spleno-caval, spleno-phrenic, spleno-azygos, right gastric–caval and right gastric–caval or azygos with a caudal shunt loop. Additional variations in shunt anatomy can be seen that do not conform to this general classification. A description of shunts involving the left gastric vein identified variants that entered the phrenic vein, the caudal vena cava, and the azygos vein.

The diameter of the portal vein decreases after the exit of the shunt vessel, and the enlarged anomalous vessel should be followed to its termination. Multiplanar reformatting and 3D rendering can be helpful in defining the anatomy. The normal tributaries of the portal vein should also be identified and their junction with the portal vein or the shunt described. The entrance of tributaries to the shunt vessel (e.g. splenic vein, left gastric veins) may affect surgical placement of occlusion devices to avoid residual shunting.

Intrapelvic masses

Intrapelvic masses rare in dogs and cats. Possible tissues of origin of intrapelvic masses include rectal, neural, vascular, glandular, or adipose tissue. Even with rectal examination, not all intrapelvic masses are palpable. Transrectal US is used widely in people but not in dogs and cats. Transabdominal US has a limited use in the diagnosis of intrapelvic masses because several factors including the superimposition of the pelvic bones, presence of gas and faecal material within the large intestine and patient body size. CT overcomes these limiting factors and is considered superior to US for the diagnosis of intrapelvic masses. Additionally, CT allows a better overview of the intrapelvic structures allowing better surgical planning and it has been shown that postcontrast heterogeneity of an intrapelvic mass is associated with malignancy in dogs (Spector et al. 2010).

Ectopic ureters

Abnormal termination of one or both ureters distal to the trigone of the bladder results in urinary incontinence and hydroureter in dogs. The distal portion of the abnormal ureter may tunnel in the wall of the bladder neck and proximal urethra before opening into the urethral lumen. In these instances, the ureter appears to terminate normally at the bladder neck but continues to tunnel caudally below the mucosa. Ectopic ureters can be normal in size but are often dilated and tortuous with associated hydronephrosis. Multiple diagnostic imaging modalities are used to diagnose ectopic ureters in dogs and cats, including CT, cystoscopy, ultrasonography, excretory urography, and vaginourethrography. Ultrasound is a useful method for diagnosis of ectopic ureters and has a high sensitivity (91%) (Lamb et al. 1998). However, the intrapelvic location of the terminal ureter in these patients and the presence of gas and faecal material in the large intestine creates difficulties for US evaluation. CT is among the most sensitive (91%) and specific (100%) methods to detect ectopic ureters (Samii et al. 2004) and has the advantage of evaluating the kidneys, ureters, and urethral termination, without interference from the pelvis, and providing functional information. The ureters fill with contrast approximately 2 minutes following intravenous contrast administration and are normally segmentally opacified as a result of peristalsis. Furosemide injection can improve the number of ureteral segments visualized and the diameter of the segments during the pyelogram phase.

The stream of contrast entering the bladder trigone is hyperattenuating to urine and can demarcate the vesiculoureteral junction. Ureters terminating in the caudal trigone or urethra travel close to midline and intramurally or occasionally extramurally. Ureteroceles can occur as dilations of the terminal ureter in dogs with ureteral ectopia, causing a thin-walled structure partially obstructing the ureter at the junction with the trigone. Secondary abnormalities include ipsilateral hydroureter and hydronephrosis resulting from chronic obstruction or pyelonephritis. In hydronephrotic kidneys, decreased renal function can be inferred from delayed pelvic and ureteral opacification although dilution of contrast may occur from urine stasis.

Small intestinal inflammatory disease

The wall small intestinal wall measurements in CT correlate well with published US and radiographic reference ranges but the wall layering is not always normally visible. If IBD cause thickening of the bowel wall, this may be appreciated on CT, however this is not always the case. Frequently, IBD only causes subtle changes in the intestinal wall (increases echogenicity or loss of the wall layering) appreciated on US but not on CT.

Hepatic and splenic nodules and masses

Hepatic and splenic nodules and masses are encountered frequently in dogs and reflect a range of pathological conditions including malignant neoplasia, benign neoplasia, nodular hyperplasia, extramedullary haematopoiesis and hematoma. Optimal management depends on accurate diagnosis and staging. Ability to noninvasively differentiate malignant from non-malignant nodules and masses would aid clinical decision making. Malignant and non-malignant hepatic and splenic nodules and masses are usually indistinguishable on US. However, the presence of target lesions, consisting of a hyperechoic lesion surrounded by a hypoechoic halo are most likely neoplastic (Cuccovillo et al. 2002). On CT there is an overlap in the pre-and post-contrast features of malignant and non-malignant nodules and masses (Jones et al. 2016).

The most common malignant splenic masses include hemangiosarcoma and fibrosarcoma. Generally, splenic hemangiosarcomas are large, complex, and hypoattenuating on unenhanced images. Malignant splenic masses tend to contrast enhance to a lesser degree than benign masses, with 55HU being a reasonable discriminating threshold. Diagnosis of malignant splenic masses is often complicated by concurrent hematoma formation from a bleeding tumour. The spleen is a frequent site of metastatic disease. Metastases often appear as hypoattenuating nodules or masses distributed throughout the splenic parenchyma or in a subcapsular location. Following contrast administration, conspicuity of the nodules is accentuated because of relatively greater contrast enhancement of the surrounding normal splenic parenchyma.

Nodular hyperplasia is a relatively common benign hepatic process that may appear as a nodule or a mass. On CT, nodular hyperplasia is non-encapsulated and may be either hypoattenuating during the early contrast phases (arterial phase) or diffusely hyperattenuating. Overall, nodular hyperplasia lesions tend to be smaller than hepatocellular adenoma or carcinoma. Hepatocellular adenomas are occasionally seen as a mass in the liver and have similar attenuation pre-and post-contrast similar to nodular hyperplasia. Biliary cystadenomas are benign neoplasms occurring more frequently in cats. These masses are composed of multiple variably sized cystic regions with little or no peripheral contrast enhancement and central fluid attenuation on CT images.

Hepatocellular carcinoma is the most common liver malignant tumour. This frequently presents as a central hypoattenuating mass with peripheral enhancement on CT images This may be partially due to the large size of typical hepatocellular carcinomas at time of diagnosis, with regions of poor perfusion and necrosis. Biliary adenocarcinomas have also been reported in cats and dogs. They are usually poorly encapsulated with heterogeneous contrast enhancement and regions of absent contrast enhancement.

Metastatic lesions to the liver may be hypervascular or hypovascular, depending on their degree of arterial blood supply (Fig.5). As in US, the presence of a target lesion has been associated to malignant nodules.

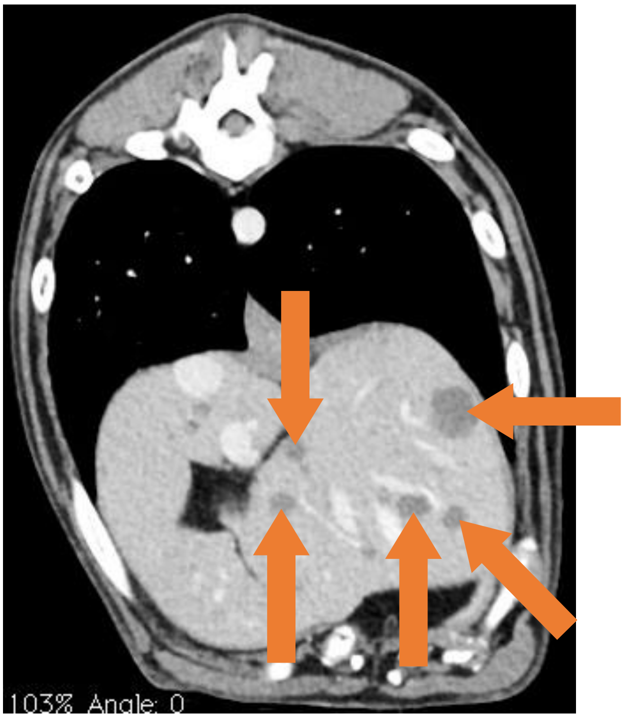

Fig.5

It is important to remember that biopsy or FNA (usually performed US guided) of the masses or nodules is always necessary for a definitive diagnosis.

<u>Insulinoma</u>

Insulin-producing pancreatic tumour, or insulinoma, is the most common pancreatic endocrine tumour described in the dog. Over 95% of insulinomas in dogs are malignant, and 40–50% have visibly metastasized at the time of surgery. Clinical signs are related to hypoglycaemia including seizure, weakness and collapse. A provisional diagnosis relies on clinical signs, laboratory data, such as the amended insulin glucose ratio, and imaging diagnosis. While amended insulin glucose ratio has high sensitivity in detection of pancreatic insulinoma in dogs, amended insulin glucose ratio shows false positive result in hypoglycaemic patient without insulin secreting tumour. Therefore, visualization of a pancreatic mass lesion is quite essential, and surgical removal of the tumour is needed for both definitive diagnosis and treatment. For an imaging diagnosis, US can be used to visualize a mass lesion in the pancreas. The accuracy of US in detecting insulinoma was reported to 35%. This is very operator-dependent, and various factors, such as the small size of the tumour, abdominal fat, gas contents in the gastrointestinal tract and patient characteristics, can interfere with a complete examination of the pancreas. With dual-phase CT angiography (early arterial phase and late phase) in evaluating for insulinoma maximizes the chance that attenuation differences will be visible for a small mass. Reports suggest that the accuracy of CT do detect insulinomas in dogs is 70%. Typically, insulinomas are best seen during the early (arterial phase), where strong contrast enhancement is present (Fig.6). Few cases have been reported, and alternate enhancement patterns are possible. Computed tomography also allows a better overview of the pancreatic anatomy for surgical planning. Therefore CT is indicated for all the patients with suspected insulinoma.

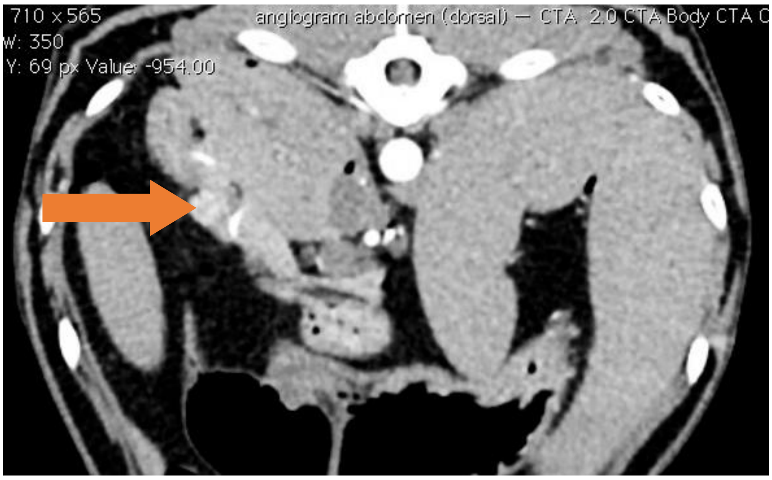

Fig.6

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