BILDDIAGNOSTIK

Rygg och buk

I Svensk Veterinärtidnings artikelserie om bilddiagnostik berättar medarbetare som jobbar eller har jobbat med bilddiagnostik på SLU om teknikerna datortomografi och magnetresonanstomografi inom smådjursdiagnostiken samt vilka omständigheter som är viktiga att beakta vid val av bilddiagnostisk metod. Efter att ha gått igenom hjärna, huvud, nacke och muskuloskeletala strukturer är det fokus på rygg och buk i den femte delen som publiceras på engelska. Som tidigare är Margareta Uhlhorn huvudansvarig författare.

Text: Dr Marion Grapperon-Mathis, *DVM, CertVDI, DipECVDI, MRCVS*

Backproblems can originate from different tissues (spinal cord, peripheral nerves, vertebrae, ligaments, paraspinal soft tissues) and from different pathologies (inflammatory, infectious, neoplastic, degenerative, traumatic, vascular).

By their 3-dimensional nature, the MRI and CT images are highly valuable to access back pathologies. However, their diagnostic efficiency depends on many technical factors which are mandatory to understand and control adequately.

Depending of the clinical signs and the localization of the problem, CT and MRI will be variably suitable imaging modalities for further investigations.

To evaluate the central nervous system, that is to say the spinal cord, the meninges and the peripheral nerves, MRI is the modality that will give the more valuable information. If the bony structures are the main concern, CT will be preferred for its spatial resolution and possibility of further 3D-printing.

Developmental disorders

Vertebral anomalies are common in dogs and can result in a combination of axial or rotational spinal abnormalities and can cause spinal canal stenosis and secondary spinal cord change.

The CT appearance of vertebral anomalies will vary depending on the specific malformation, but common findings include alteration in vertebral shape, reduced attenuation when mineralization is incomplete, and vertebral column curvature abnormalities. Vertebral canal stenosis can lead to spinal cord impingement or compression, which can be documented using CT myelography. MR features are similar to those seen with CT but the spinal cord pathology is often more clearly detected.

Craniocervical junction malformations such as Chiari-like malformations, atlanto-axial overlap and atlanto-axial instability are usually well evaluated with plain CT but MRI can be preferred particularly in case of Chiari-Like malformation to assess the degree of cerebellar herniation and the presence of syringohydromyelia.

In case of caudal cervical spondylomyelopathy (Wobbler's) affecting large and giant breeds dogs, CT will depict very well the altered vertebral malformations and with the use of myelography, compressive lesions, more or less dynamic, will be visible. MRI will however add information of the chronic spinal cord changes such as edema, gliosis and/ or dilated central canal. (Figure 1.)

In case of clinically significant scoliosis or kyphosis, CT will have the benefit of the realization of 3D printing of the spine, useful for surgical planning.

Plain CT is of poor diagnostic value in case of subarachnoid diverticula. The use of CT-myelography will be required and will show the blind-ending subarachnoid dilation. In those cases, MRI will be preferred as giving a non-invasive diagnosis and additional information on the status of the compressed cord parenchyma.

Traumatic and vascular disorders

Fractures and luxations are both clearly delineated on CT images, and multiplanar or 3D reformatting are often useful to better characterize complex injuries. CT has the advantage of being faster than MRI. CT myelography will be employed to define the presence and extent of spinal cord compression due to fracture displacement or hemorrhage. Although MRI is superior to CT for detecting spinal cord and other soft tissue injury, it is less sensitive and specific for detecting and characterizing vertebral fractures or subluxations.

Ischemic ± hemorrhagic myelopathy with cartilaginous emboli in meningeal or spinal vessels (fibrocartilaginous embolisms) is better assessed with MRI. The CT imaging features will be limited to a non-specific non-compressive focal increase in spinal cord diameter.

Inflammatory and infectious disorders

Non- infectious inflammatory spinal disorders (granulomatous meningomyelitis, steroid-responsive meningitis-arteritis) are often unremarkable on CT or MRI. Diagnosis of such disorders is often made from signalment, clinical presentation, cerebrospinal fluid analysis and response to therapy. MRI can sometimes show paravertebral muscle changes or post contrast meningeal–parenchymatous or enhancement. (Figure 2.)

Radiographic examination is an excellent test for diagnosis and monitoring of discospondylitis. CT and MRI are most often employed when neurologic deficits are present, or the patient has other clinical signs not explained by radiographic or ultrasonographic findings. CT with angiography and MRI will be relatively similar in diagnostic utility, showing the vertebral endplate changes, the paravertebral soft tissues involvement and the potential compressive myelopathy.

Degenerative disc disease and disc herniation

Intervertebral disc herniation has been described as been classically classified as Hansen type I and II with a 3rd type more recently recognized thanks to the increased access to CT/MRI, called high-velocity low-volume disc herniation.

CT has the benefit of being faster and cheaper and conventional

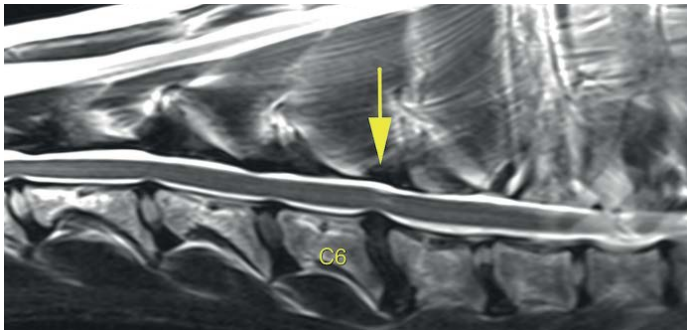

Figure 1. T2W sagittal image of the cervical spine showing the protrusion of the C6-C7 intervertebral disc and the focal central intramedullary hyperintensity seen at the same level (gliosis).

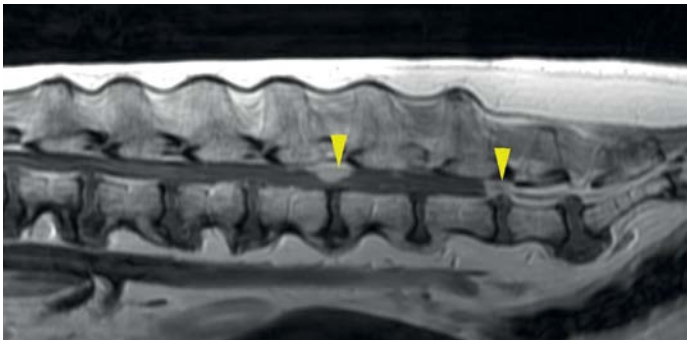

Figure 2. Post-contrast T1W sagittal image showing the multifocal intramedullary ± meningeal enhancing focal lesions in a case of immune-mediated meningoencephalitis.

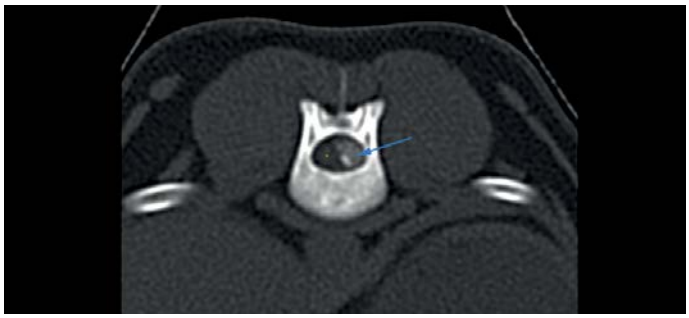

Figure 3. Reconstruction of a computed tomography image in bone algorithm showing an extruded mineralized, hyperattenuating disc (arrow), causing a moderate right lateral disc compression of the adjacent spinal cord.

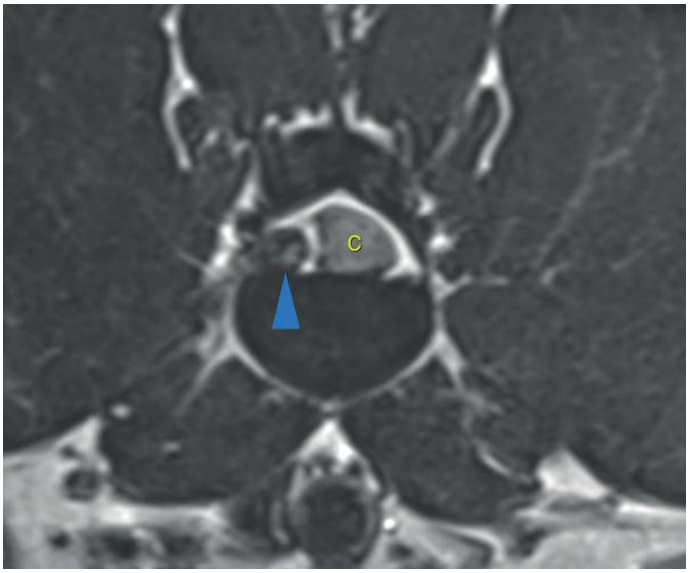

Figure 4. T2W transverse image in the lumbar region showing an heterogeneous but well-defined extruded disc material causing right lateral extradural compression of the cord and obliteration of the entrance of the intervertebral foramen.

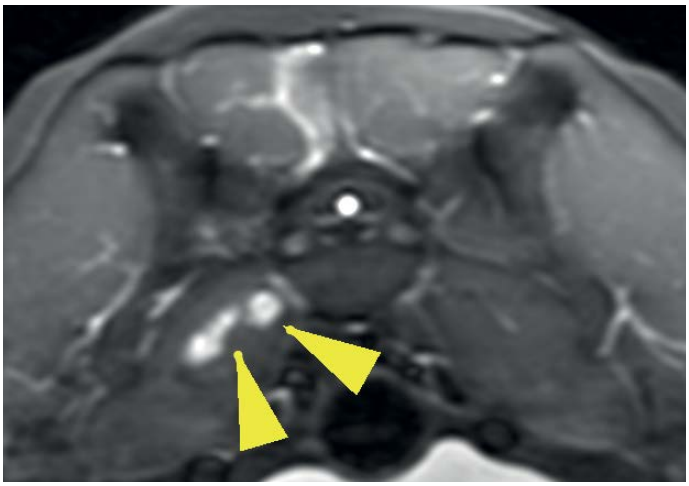

Figure 5. STIR transverse image at the level of L7, showing a thickened right nerve root (femoral nerve component).

CT has been found to be relatively adequate for the diagnosis and localization of mineralized disc extrusions in chondrodystrophic breeds on the premise the herniated disc material is often mineralized in these breeds. (Figure 3.) However, MRI is the best imaging modality. It is a very accurate method for localization of disc herniation, determination of laterality and degree of spinal cord compression, which are important considerations for surgical planning. (Figure 4.) The procedure is non-invasive and produces high-resolution multiplanar images of the intervertebral discs, spinal cord parenchyma and subarachnoid and epidural spaces. It can also provide information on the presence and extent of spinal cord edema, signs of myelomalacia and/ or presence of hemorrhage which can carry a prognostic value.

Brachial and lumbar plexuses

In case of neoplastic, inflammatory or vascular changes affecting the spinal cord and the peripherical nerves, MRI is considered better than CT. (Figure 5.) In certain case of neoplasia, CT can however give enough information when angiographic and/or myelographic contrast studies are performed.

In the case of cauda equina syndrome, MRI will allow to identify the amount of degeneration of the intervertebral disc, the degree of compression of the cauda equina and the different soft tissue structures (ligaments, synovial tissue) that may contribute to the syndrome. CT will only be helpful in detecting bone density changes (sclerosis, spondylosis, malalignment of the lumbosacral junction, stenosis of vertebral canal) but the evaluation of the soft tissues structures might be limited, only mildly improved after IV administration of contrast medium.

For the diagnosis of avulsion of the brachial plexus (more commonly seen than avulsion of the lumbosacral plexus), CT with myelography is usually of very good diagnostic help.

FORTSÄTTER PÅ NÄSTA SIDA ▸

CT/MRI ABDOMEN

Computed tomography provides a rapid and effective method for identifying and characterizing abdominal disease. It overcomes the superimposition and narrow contrast range of radiographs and is relatively inhibited by motion artefacts unlike abdominal MRI.

Abdominal CT can be performed in sedated or anesthetized patients depending of the clinical indications. The normal appearance of the abdominal organs in CT is well described.

Computed tomography has become the most useful modality in small animal cancer patients as it is an excellent tool for pre-operative planning of many mass lesions through the evaluation of their origin and extent and tumor staging through the assessment of tumor vascularity, vascular invasion, tumoral thrombosis, locoregional lymphadenopathy and potential metastases. CT-assisted biopsies and fine needle aspirates are also excellent means to access safely deeply seated structures even if ultrasound-guided samplings are generally preferred.

The need for general anesthesia, long acquisition times, and respiratory motion artifacts are the main disadvantages associated with MRI. However, advances in hardware and software have allowed acquisition of images that are free of motion artifacts with shorter imaging times

Figure 1. A 3D Volume Rendering reconstruction of an abdominal CT angiography nicely demonstrating a shunting vessel (S) between the portal vein (PV) and the caudal vena cava (CVC). The vessels and the kidneys are filled with iodinebased contrast medium and are therefore clearly seen in the image.

Hepatobiliary system

In case of diffuse hepatic disease (acute inflammation, congestion and storage diseases), the CT findings are rather non-specific and not documented in small animals as well as they are in humans.

CT is mainly indicated to explore cranial abdominal masses with suspected hepatobiliary origin and for the investigation of portosystemic shunts. It is generally useful to identify, characterize and localize lesions such as abscesses, neoplasia and cysts.

Dual phase or triple phases angiography CT studies have shown to be very useful. In case of portosystemic shunt (Figure 1,) acquired or congenital, the vascular anatomy will be accurately shown, and additional 3-dimensional image reconstructions will be of great help for surgical planning.

CT-angiography can also be valuable in case of infarcts of the liver due to thrombosis, embolism or secondary to torsion.

Digestive tract

Due to motion artefacts from breathing and peristalsis as well some potential streak artefacts from nearby great vessels, MRI of the digestive tract is limited.

Ultrasound is commonly used to evaluate the gastrointestinal tract but CT can be useful in case of focal masses and neoplastic processes of large size. When coupled with the administration of water in the stomach, CT angiography allows excellent delineation of gastric lesions which can be difficult to evaluate well on ultrasound.

In case of inflammatory bowel disease, ultrasound should remain the preferred imaging modality coupled with biopsies (surgical or endoscopical). The depiction of the intestinal wall layers in CT and MRI images depends of the size of the dog and the post contrast study which might be of suboptimal quality.

In case of mechanical obstruction, CT is not superior to ultrasonography.

Urogenital tract

The use of CT to accurately access the kidneys function is still under investigations. However, CT can give informations about the morphology and the renal vascularization (using angiography).

Renal lesions such as neoplasia, abscesses, cysts, nodules, hydronephrosis, infarction, traumatic injurya and mineralization are well seen on CT but all these conditions are usually recognized on ultrasound. There are however some large or complex renal masses where CT can be beneficial.

CT is well suited to identify and follow the ureters, particularly in cases of suspected ureteral ectopia. For this, intravenous angiography is performed, and serial images are acquired in the region of the urinary bladder trigone area and urethra to detect altered ureteral anatomy.

It can be useful to search for ureteral calculi and ureteral obstruction when the ultrasonographic examination is prevented by gas or effusion.

To investigate the genital tract, MRI and CT will be useful as the pelvic region will be less affected by gastrointestinal peristal-

sis and secondary motion artefacts. The MRI has the additional advantage to not be limited by the presence of the pelvic bones. Indeed, the image quality of CT can be significantly impaired by the presence of thick pelvic bones causing beam hardening streaks artefacts. In case of vaginal or urethral tumor, MRI and CT could be equally considered as useful imaging modalities.

Adrenal glands

In ultrasound, due to its craniodorso-medial position, the right adrenal gland can be hard to identify, particularly in deep-chested animals. CT allows the identification of each of the adrenals with ease whatever the morphology of the patients.

CT is particularly useful in case of adrenal tumors to assess the vascular invasion (phrenicoabdominal and caudal vena cava) (Figure 2.) Again, the use of intravenous contrast increases the conspicuity of the different anatomical structures.

In case of Cushing's disease of uncertain types, CT of the head to evaluate the pituitary gland can be done as well as evaluation of the adrenals.

MRI of normal adrenals glands has been described in dogs and is likely to provide all the requested information in case of adrenal masses. As CT, it can allow the imaging of the entire hypothalamo-hypophyso-cortical axis when imaging both the head and abdomen.

Pancreas

Pancreatic masses can be a diagnostic challenge and CT can provide some additional information. Particularly, CT has been reported to have a better sensitivity and specifity than ultrasound in the diagnosis and staging of insulinomas.

Insulinomas are the most common endocrine pancreatic neoplasms in dogs, ferrets and humans, but are rare in cats. More than 95% of insulinomas in dogs are malignant and about 40–50% of the tumors have visibly metastasized at the time of surgery. Thus, the importance of an early diagnosis. Insulinomas can measure only a few millimeters and are therefore particularly hard to detect. Several studies in dogs showed insulinoma to have a characteristically enhancement pattern helping in its identification and guiding surgery.

Otherwise CT can be useful for evaluation and diagnosis of pancreatic necrosis that can be hard to appreciate on ultrasound. Pancreatic necrosis is a focal or diffuse area of non-viable pancreatic parenchyma which will be conspicuous on post IV contrast imaging as non-enhanced parenchyma.

Spleen

CT and in a lesser extent MRI are very useful in cases of splenic masses (neoplastic or not), splenic torsion or subcapsular hemorrhage (Figure 3), mainly thanks to the 3-dimensional nature of the images and the realization of angiographic studies. •

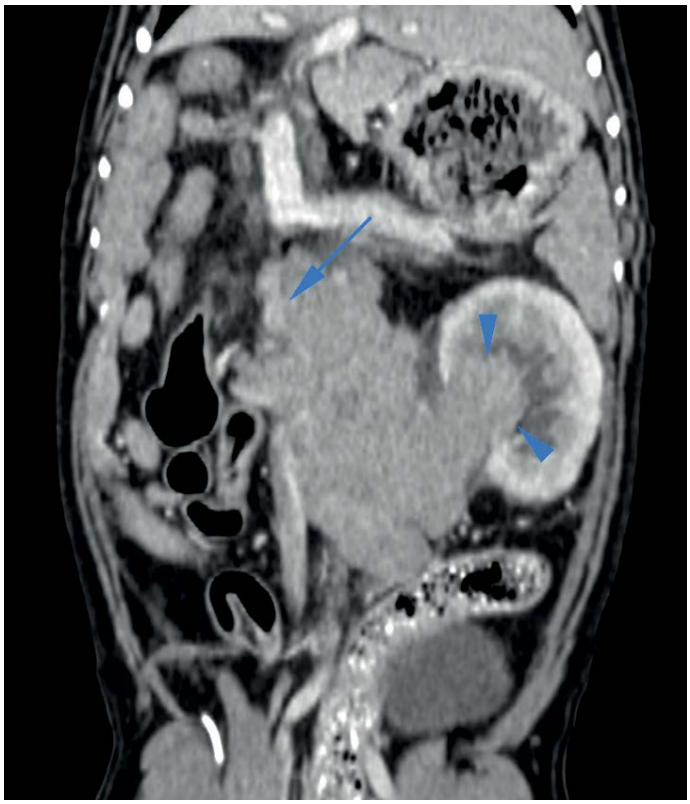

Figure 2. A dorsal plane reconstruction of an abdominal CT examination post contrast where a large adrenal mass in the left adrenal is invading the caudal vena cava (arrow) and through the renal vein is invading also the left kidney (arrow heads). The mass was histopathologically diagnosed as a phaechromocytoma.

Figure 3. A dorsal plane reconstruction of an abdominal CT examination post contrast showing a large heterogenous splenic mass with subcapsular hemorrhage (arrow heads).