Diagnostic imaging plays an important role in characterization of focal and diffuse hepatic diseases. Radiography and ultrasound (US) serve as first-line diagnostic imaging modalities of choice for the detection and characterization of hepatic diseases, however the majority of findings using these imaging tests are often non-specific. The identification of focal mass lesions in the liver using radiography and US usually suggest the presence of neoplasia, abscess, or granuloma as possible differential diagnoses, and distinction between etiologies often requires additional testing. Most commonly, diffuse hepatic diseases reflect metabolic, infectious or inflammatory causes, though overlap with multicentric neoplastic diseases such as round cell neoplasia is also commonly seen. In each case, advanced imaging along with image-guided sampling can provide additional information regarding diagnosis, surgical planning, and staging.

Cross-sectional imaging modalities remove the superimposition present in radiography, and typically provide superior contrast resolution. US is commonly recognized as being operator dependent, relying on the experience of the sonographer for diagnostic accuracy, and can therefore yield variable results. Computed tomography (CT) and magnetic resonance imaging (MRI) have become more available recently, and experience with these advanced imaging modalities in veterinary medicine is increasing. As imaging technology advances, so too does our ability to apply new techniques in differentiating benign versus malignant disease. Finally, CT and MRI provide superior multiplanar reformatting and 3-dimensional imaging, which are better suited for surgical planning.

Focal Hepatic Disease

Characterization of focal hepatic disease has been improved with cross-sectional imaging techniques, including US, CT and MRI. US is by far the most commonly employed imaging modality in the characterization of hepatic nodules and masses, and findings that aid in the distinction of benign from malignant masses and nodules have been reported. Specifically, the presence of additional abnormalities such as hepatic lymphadenopathy, effusion, and/or splenic lesions increase the likelihood of a malignant neoplasm, whereas the presence of nodules alone suggest vacuolar hepatopathy, commonly related to hyperadrenocorticism, steroid hepatopathy, or diabetes mellitus. However, if nodules should appear target-like on US examination, the positive predictive value for malignancy increases significantly.

In hepatocarcinogenesis, the evaluation of hepatic nodule hemodynamics in people is key in characterizing nodules as regenerative or neoplastic. The evaluation of arterial and portal venous blood supply is important in making this distinction, and can be accomplished with dynamic imaging on contrast enhanced US (CEUS), contrast enhanced CT (CECT) and MR techniques with and without contrast enhancement. In veterinary medicine, the utility of contrast enhanced harmonic US has recently been explored. US contrast agents consist of small gas bubbles surrounded by a shell. The addition of US contrast agents increases the ability of US to differentiate between benign and malignant hepatic masses, though there are some limitations. As with most contrast imaging, the enhancement patterns of tissue during arterial, venous and equilibrium
phases can reveal important information regarding blood supply and, indirectly, malignancy of lesions. Hepatic imaging also involves the assessment of the portal venous phase and is additionally influenced by the presence of Kupffer cells. Contrast enhancement patterns in US of hepatocellular carcinoma (HCC) are at least in part dependent on the presence of Kupffer cells, which in people show a decrease in concentration with increasing histologic grade. In dogs, variability in contrast enhancement patterns of HCC were noted in the parenchymal phase, however, all were decreased in signal relative to normal hepatic parenchyma. Metastatic lesions associated with hemangiosarcoma (HSA) also presented with a specific contrast enhancement pattern. In one study, HSA metastases exhibited a ring of contrast enhancement on the arterial phase, and limited enhancement on the parenchymal phase. In another study, there was no enhancement noted in any cases of HSA metastases on any phase of the contrast examination. At this time, the availability, practicality, and cost of US contrast agents has kept this test from becoming a staple in veterinary diagnostic imaging.

Dynamic contrast enhanced computed tomography (dynamic CECT) is rapidly becoming more popular as a means for characterizing hepatic masses and nodules in veterinary patients. The ability to assess the hemodynamics of hepatic masses and nodules during arterial, portal venous, hepatic venous, and equilibrium phases of contrast enhancement allows accurate characterization of benign versus malignant neoplastic processes in people as well as in veterinary patients. In people, CT arterial portography (CTAP) with selective contrast administration into the hepatic artery has even greater sensitivity for the detection of HCC nodules. Recently the utility of dynamic CECT in the evaluation of canine hepatic masses was reported. HCC masses typically showed evidence of capsule formation, with regions of central or peripheral hyperattenuation in the arterial phase and hypoattenuation during the portal venous and equilibrium phases relative to the normal hepatic parenchyma. In addition, HCC masses also showed evidence of cyst formation suggestive of regions of necrosis. Hepatic adenomas and nodular hyperplasia typically showed diffuse contrast enhancement on the arterial phases and were typically isodense relative to the hepatic parenchyma on the portal phase and equilibrium phases.

The utility of MRI in the characterization of focal hepatic lesions in veterinary patients has not been well described. One study examined the use of T1-weighted gradient recalled echo chemical shift imaging (T1W GRE CS), T2-weighted with fat saturation (T2W FS) and contrast enhanced T1W images in the characterization of 27 hepatic masses as benign or malignant. Correlation with histopathology and cytology was excellent, though 2 benign nodules were incorrectly characterized as malignant. In people the use of diffusion weighted imaging, calculation of contrast to noise ratio as well as liver specific contrast agents have been employed to increased the certainty of diagnosis using non-invasive techniques. These MR imaging techniques correlate well with already established dynamic CECT, CTAP, and CEUS imaging techniques as well as with histological grading of HCC nodules in people.

**Diffuse Hepatic Disease**

On ultrasonography, diffuse hepatic disease is commonly associated with changes in size, shape and echogenicity or, potentially, a normal sonographic examination. Many
detected changes are non-specific, and further tests are recommended. CEUS has proven useful in evaluating the liver under these circumstances as well. In the evaluation of diffuse hepatic nodules, there was an association of malignancy with a hypoechoic nodule at surrounding normal liver peak contrast enhancement.8 Benign nodules were isoechoic to the surrounding normal liver at peak contrast enhancement.8 The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy 100%, 94.1%, 93.8%, 100%, and 96.9%, respectively.8 In addition, CEUS also aided in the detection of nodules not seen on US performed without contrast in the case of lymphoma.6

In cases of diffuse metabolic disorders in people, diagnostic imaging features on MRI may be used to help identify fat accumulations, or steatosis. In people, the use of in-phase and out-of-phase imaging as well as the use of diffusion-weighted imaging (DWI) can provide information about the fat content of the liver in cases of hepatic steatosis.19 20 Steatosis in people is typically associated with alcohol consumption; however, other health issues, including obesity, diabetes mellitus, and genetic conditions can contribute to fat storage and cellular damage. Though accumulations associated with other metabolic syndromes such as copper storage disease are not reliably diagnosed via imaging techniques, the utility of MR in the diagnosis of these diseases is promising in people and has not been explored in veterinary patients.21

In summary, advances in imaging technology, specifically with regard to specialized contrast agents available in cross-sectional imaging modalities provide more accurate information regarding malignancy and staging than ever before, and should always be an important part of surgical planning in the veterinary patient.

References


