Specific indications for sonographic evaluation of the spleen include the palpation of generalised splenomegaly or an abdominal mass, abdominal trauma, and haemoperitoneum. The spleen may also be evaluated to stage patients for metastatic disease (for example mast cell tumour metastases), or in cases of immune mediated disease for example immune mediated thrombocytopenia which may be secondary to neoplasia. It is important to recognise, however, that sonographic abnormalities are usually non-specific. Interpretation of splenic ultrasound findings must be made in conjunction with other clinical information - history and signalment, the clinical examination, the findings of blood tests, and the results of sampling of the spleen by fine needle aspiration or cytology.

ENSURE YOU EVALUATE THE ENTIRE SPLEEN
Ultrasound provides you with a thin cross-sectional image, and the ultrasound beam must be ‘swept’ through the entire organ to ensure a thorough examination. The spleen should be evaluated in both transverse and longitudinal planes. The head of the spleen is fixed by the gastrosplenic ligament, and resides in the left craniodorsal abdomen. It may be visualised from a ventral abdominal approach, however gas or ingesta within the gastrointestinal tract may prevent evaluation. Alternatively the splenic head is seen by a left dorsal intercostal approach through the 11th to 12th intercostal space. The body and tail of the spleen extend along the left and ventral abdominal wall. The splenic vein should be traced to the portal vein, and the splenic hilus evaluated for the presence of splenic lymph nodes. Consideration should be given to the presence of ‘accessory spleens’, small islands of splenic tissue implanted on the mesentery, which may be mistaken for lymph nodes (Rossi et al. 2010).

Splenic size is assessed subjectively. Splenomegaly may be iatrogenic due to sedatives or anaesthesia, particularly caused by acepromazine and barbiturates (O’Brien et al. 2004). The spleen has a characteristic triangular shape in transverse plane and a ‘strap’ like shape in longitudinal plane. The head of the spleen curves axially. The normal splenic capsule is smooth, visible as a hyperechoic line when the ultrasound beam strikes the capsule perpendicularly. The normal spleen has a fine granular echotexture, and is hyperechoic relative to the left renal cortex and the liver. The intra-parenchymal splenic veins are visible as a converging ‘y’ shape near the splenic hilus, where they exit the spleen to join the splenic vein proper. A common incidental finding are multifocal hyperechoic nodules most commonly near the splenic hilus around the splenic veins, or peripherally. They may cast a distal acoustic shadow. These are ‘myelolipomas’, collections of fatty tissue of no pathologic significance (Schwarz et al. 2001).

FOCAL OR MULTIFOCAL CHANGES
Splenic nodules are a common and non-specific finding. An important differential is nodular hyperplasia, a frequent finding in older dogs. Hyperplastic nodules are usually isoechoic and only recognised when they distort the splenic capsule. In some cases they may alter splenic echotexture and echogenicity, thus cytologic or histopathologic evaluation of lesions is crucial in forming a diagnosis. Differentials for splenic nodules include: myelolipomas, nodular hyperplasia, extramedullary haematopoesis, early haematomas, infection, abscess, splenic necrosis, neoplasia (primary or metastatic).

Splenic abnormalities are often recognised in patients with primary immune-mediated haemolytic anaemia. In one study, 7 of 27 dogs (26%) had splenic abnormalities, including splenomegaly with patchy hypoechoic nodules, and heteroechoic nodules. These changes were attributed to extramedullary haematopoesis, lymphoid hyperplasia, and acute infarcts. (Cruz-Arambulo, 2007).

Splenic necrosis or infarction may be wedge-shaped with the broad base toward the periphery. As the infarcts age, they change from poorly marginated hypoechoic or complex lesions, sometimes with a ‘lacy’ appearance, maturing to hyperechoic regions that may distort the splenic margin. Evaluation for the absence of blood flow using Colour or Power Doppler may be useful to distinguish from other lesions, although an absence of signal may reflect slow flow and incorrect Doppler Gain and Pulse Repetition Frequency settings.

Splenic abscesses are uncommon and highly variable in appearance. They usually have irregular poorly defined margins and are hypoechoic. Some lesions are complex with variable cystic and solid components. Areas of intense hyperechogenicity, casting ‘dirty’ distal acoustic shadow, indicates the presence of gas-forming microorganisms. Adjacent mesenteric fat may be inflamed with a hyperechoic, hyperattenuating appearance, and focal effusion.

Splenic haematomas have variable appearance; small, early haematomas are hyperechoic, while larger haematomas are anechoic to hypoechoic collections of unclotted blood. In the later stages as the clot organises, the echogenic content is surrounded by anechoic fluid. On serial ultrasound evaluation, haematomas reduce in size as they resolve. Splenic haematomas may be large in size, and may be confused with malignancies such as haemangiosarcoma.
Splenic neoplasia may manifest with solitary or multifocal masses. The type of splenic neoplasm cannot be determined from the ultrasound appearance. The sonographic appearance of splenic haemangiosarcoma (Wrigley et al. 1989) and lymphoma (Wrigley et al. 1988) have been described, but definitive diagnosis requires cytologic or histopathologic evaluation. Beware the patient with hypoechoic splenic and hepatic lesions; whilst neoplasia is possible, consideration must be given to concurrent splenic and hepatic nodular hyperplasia. The presence of a solitary ‘target’ lesion - hyperechoic centre with a hypoechoic rim - has a positive predictive value for malignancy of 74%. Multiple target lesions in the spleen and liver increases the positive predictive value to 81%. (Cuccovillo et al. 2002). If neoplasia is suspected, thoracic radiographs should be taken to evaluate for pulmonary metastases. Echocardiography may also be considered to check for right auricular masses.

In recent years, contrast-enhanced ultrasound has been evaluated for the differentiation of malignant from benign splenic lesions (Rossi et al. 2008, Ohlerth et al. 2008, Nakamura et al., 2010). Splenic malignancies are hypoechoic relative to adjacent normal parenchyma in the early and late vascular phases compared to benign lesions. In the late vascular phase, hypoechoic pattern was associated with malignancy, with a sensitivity of 81% and specificity of 85% (Nakamura et al., 2010).

DIFFUSE SPLENIC CHANGES

In most cases, ultrasound is not helpful to distinguish between causes of diffuse splenic disease due to the overlap of sonographic appearances. Pathologic differentials for diffuse splenic disease include: infection, immune mediated disease, lymphoma, leukaemia, neoplastic infiltrates, splenic congestion, splenic torsion, chronic haemolytic anaemia, and parasitic infection (e.g. with Mycoplasma haemofelis, Babesia, or Ehrlichia).

Splenic congestion usually presents as an isoechoic to slightly hypoechoic spleen. It occurs with disturbances to splenic or portal circulation, such as splenic vein thrombosis, splenic torsion, portal vein compression e.g. by severe hepatic disease. Splenic torsion, splenic vein thrombosis, and acute splenitis may all lead to splenic infarction and necrosis, with marked splenomegaly with a hypoechoic and ‘lacy’ appearing parenchyma (Saunders et al. 1998). A hilar perivenous hyperechoic triangle may be seen with splenic torsion (Mai, 2006). Careful evaluation of the spleen and portal veins with B-mode and Colour Doppler is recommended. Colour Doppler of the splenic parenchyma is also useful to see if blood flow is present within the spleen. With diffuse neoplastic disorders such as lymphoma or mast cell infiltration, the parenchyma may appear more coarse and heterogeneous. Fine needle aspiration and cytology is recommended in such cases.

SAMPLING OF THE SPLEEN

If splenic abnormalities are found on ultrasound, sampling is recommended unless the diagnosis is obvious from other clinical information. Ultrasound guidance allows direct sampling of focal lesions. Sampling is most commonly performed by fine needle aspiration, which is minimally invasive, relatively inexpensive, and may be performed under sedation. A non-aspiration technique is preferred as there is less blood contamination and produces higher quality cytologic samples (LeBlanc et al. 2009). In one study cytologic diagnosis corresponded with the histopathologic diagnosis in 61.3% of cases, while in 22.6% of cases, histopathology was required to distinguish between reactive and neoplastic conditions. Multiple similar appearing lesions were associated with malignancy, while solitary lesions were more often benign. (Ballegeer et al. 2007).

CONCLUSION

While the sonographic appearance of diffuse or focal splenic disease may suggest one diagnosis is more or less likely, the marked overlap in sonographic appearance of lesions means that fine needle aspiration or biopsy is required for diagnosis. Correlation of sonographic findings with other clinical information is important in the interpretation of findings. Contrast enhanced ultrasound appears to be a promising technique for differentiating between malignant and benign focal splenic lesions.