Surgical Management of Splenic and Liver Masses
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Key points:
- Primary ruleouts for dogs with splenic masses include hemangiosarcoma, other sarcomas, hematoma and lymphoma.
- Splenectomy can safely be performed by dividing the splenic, left gastroepiploic, and short gastric arteries.
- Primary ruleouts for dogs with solitary liver mass are hepatocellular carcinoma and adenoma, both of which have very low metastatic rates. The primary ruleout in cats is hepatobiliary cystadenoma, which does not metastasize.
- The long term prognosis for dogs and cats undergoing resection of liver masses is generally excellent.

Splenic masses
Hemangiosarcoma (HSA) is the most common tumor of the canine spleen. The tumor occurs most commonly in large breed dogs, but on rare occasions can occur in small breed dogs as well as cats. Other relatively common sites include the right auricular appendage, the liver, the skin, and the subcutaneous tissues and underlying musculature. The metastatic rate of splenic HSA approaches 100%. Common metastatic sites include the liver, omentum and mesentery, lungs and other sites.

Dogs with HSA are presented either for chronic nonspecific signs such as lethargy, anorexia and weight loss, often with abdominal distension; or for acute weakness/collapse and shock related to spontaneous intra-abdominal bleeding. Weakness can occasionally be episodic. Abdominal ultrasound is very reliable for confirming that the spleen is the origin of the mass, and is particularly valuable when there is significant hemoabdomen. Ultrasound is not reliable for distinguishing liver metastases from nodular hyperplasia.

Rule outs for splenic masses include hematoma, other sarcomas such as fibrosarcoma and leiomyosarcoma, histiocytic sarcoma, and lymphoma. With the exception of hematomas, all of these are relatively rare in comparison to HSA. Hematomas can occur in middle aged and older dogs of all sizes, are occasionally associated with hemoabdomen, cause nonspecific signs, and are associated with an excellent prognosis following splenectomy. They probably result from spontaneous hemorrhage within hyperplastic nodules. Fibrosarcoma, leiomyosarcoma and histiocytic sarcoma all are associated with high metastatic rates and limited survival following splenectomy. Lymphoma typically causes splenomegaly, but can occasionally present as a mass lesion.

The veterinarian’s educated guess as to whether a splenic mass lesion is likely to be HSA can be valuable to owners attempting to decide whether or not to opt for splenectomy. In general, abdominal fluid analysis or aspiration of the mass lesion are unlikely to be helpful: most splenic masses do not readily exfoliate cells. The 2/3, 2/3 rule states that approximately 2/3 of splenic masses are malignant, and that of these, approximately 2/3 are HSA. Approximately 70% of all dogs with a splenic mass and hemoabdomen have HSA, and if the patient is a large breed dog, the odds of HSA are probably slightly higher. At present, there are no imaging tests that reliably distinguish HSA from other splenic masses. Dogs with HSA often are anemic, and a CBC may demonstrate schistocytes and/or acanthocytes.

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Preoperative care for patients with hemobdemen and varying degrees of hemodynamic instability may include crystalloids, colloids, and blood products. A significant proportion of HSA/hemoabdomen patients have consumption-related coagulopathies including thrombocytopenia and prolonged PT and/or PTT. Coagulopathies are difficult to completely normalize by administration of blood products, and surgery is often performed in the face of some degree of clotting dysfunction. Dogs with HSA and hemoabdomen are prone to ventricular tachyarrhythmias: blood loss and the presence of a large abdominal mass compromise venous return to the heart and in turn impair cardiac output, which reduces coronary blood flow and causes myocardial hypoxia. These factors may be worsened by anesthetic drugs, by positioning the dog on his back, and by reperfusion injury following removal of the mass. For these reasons, dogs with hemoabdomen should have continuous ECG monitoring, should be moved quickly to surgery once anesthesia is induced, and should not be positioned in dorsal recumbency until absolutely necessary.

Splenectomy is usually a straightforward surgical procedure. Care must be taken not to rupture the splenic mass as the spleen is being exteriorized – this is best prevented by making a large incision, introducing both hands into the abdomen, and carefully lifting the spleen from below. Any omental adhesions are divided before ligating the blood supply to the spleen itself. Rather than ligating individual branches of the splenic artery and vein close to the spleen, the splenic, left gastroepiploic and short gastric arteries and veins can be divided to save time. The left gastroepiploic artery supplies the greater curvature of the stomach, but there is adequate collateral circulation to assure that gastric necrosis will not occur. Ligations can be performed by hand, with an LDS stapling device (Covidien), or with a vessel sealing device such as a Ligasure (Covidien) or harmonic scalpel (Ultracision, Ethicon).

**Figure 1:** The splenic artery and vein (above) and the left gastroepiploic artery and vein (below)

Postoperative care should include pain management, fluids and/or blood products, and in hemoabdomen patients, ECG monitoring. Approximately 20-40% of splenic HSA patients develop ventricular tachyarrhythmias, and these are more likely to be detected with continuous rather than intermittent ECG monitoring. Tachyarhythmias associated with splenic HSA typically respond well to lidocaine or procainamide, and are rarely fatal.
Histopathologic reports pertaining to dogs with splenic masses must be interpreted carefully. While a diagnosis of HSA can be believed, a diagnosis of hematoma should be considered suspicious, particularly if the patient is a large breed dog with hemoabdomen. When a large splenic mass is submitted, the histology technician typically prepares only 3-4 sections from the mass: if the mass consists of mostly hematoma adjacent to a relatively small area of HSA, an incorrect diagnosis may result.

In patients with histologically confirmed HSA, reported median survival times range from 2-3 months, and survival beyond 1 year is unusual. A number of reports have suggested that survival times can be extended by administration of chemotherapy following splenectomy. Reported median survival times with chemotherapy have generally been in the 3-5 month range, although MST’s as long as 9 months have been reported. Most reports on chemotherapy for splenic HSA have described nonrandomized retrospective studies, and while they provide a preliminary suggestion that chemotherapy may be of value, randomized prospective trials are needed. There is also preliminary evidence that metronomic chemotherapy may have efficacy in splenic HSA. Metronomic chemotherapy employs low doses of oral chemotherapeutic drugs on a daily basis at home, and is thought to work through an antiangiogenic effect.

Liver masses

The two most common primary liver tumors in dogs are hepatocellular carcinoma (HCC) and hepatocellular adenoma. Both of these tumors most commonly present as a large, solitary liver mass. HCC has a very low metastatic rate, and hepatocellular adenoma does not metastasize. Hemangiosarcoma may occasionally arise in the liver.

Dogs with liver tumors typically present with nonspecific signs such as anorexia, weight loss, lethargy and abdominal distension. Primary liver tumors are occasionally discovered as incidental findings on an abdominal ultrasound performed for other reasons. The combination of a liver mass and hemoabdomen is highly suggestive of liver HSA. Because liver masses typically do not significantly reduce the amount of functional liver tissue, they usually are not associated with impairment of liver function. Clinical pathology may show mild anemia, leukocytosis, and variable liver enzyme levels. Approximately 50% of dogs with HCC are reported to have thrombocytosis (>500,000 platelets). Radiography may reveal a space-occupying mass in the cranial abdomen; centrally-located masses may displace the stomach caudally. Abdominal ultrasound is the key imaging test. While AUS is very reliable for confirming the presence of a liver mass, it is not reliable for determining resectability. The major determinant of resectability is whether the mass invades the hilus or base of the liver; because the divisions between lobes and the junctions of the lobes with the hilus are indistinct on all imaging tests, resectability is usually uncertain prior to surgery. However, most liver masses are confined to a lobe and do prove resectable. AUS-guided aspiration cytology or biopsy of liver masses are accurate tests for the diagnosis of HCC or HC adenoma, but because these 2 lesions behave similarly, preoperative knowledge of tumor type rarely effects clinical decision-making.

Liver masses are treated by liver lobectomy. The main potential complication of this procedure is hemorrhage, which can be life-threatening if uncontrolled. Lobectomy is generally easier to perform on the left side of the liver than on the right, because the left- sided lobes have a long, narrow hilus and are distant from the vena cava, whereas the right-sided lobes have a broad hilus and are situated near the vena cava. Available techniques for liver lobectomy include
the encircling ligature technique, surgical stapling, and vessel sealing devices. The encircling ligature technique is the most versatile and reliable technique. Staples generally do not grasp normal, friable liver tissue well, and the liver tissue of dogs is often too thick to staple; however, staplers can be useful for fibrotic and relatively thin liver lobes. Vessel sealing devices are also good for relatively thin lobes, and are easier to position at the base of the liver than are stapling devices. When the tissue at the base of the lobe is too thick, it can be finger-fractured to reduce the volume of parenchyma prior to application of the vessel sealing device. In a normal dog study in which the techniques were compared, surgery times for the techniques were equivalent, the encircling ligature provided the best resistance to leakage, and all techniques were found to be safe for clinical use. The encircling ligature technique is illustrated below.

![Figure 2: The encircling ligature technique for liver lobectomy](image)

The prognosis for dogs undergoing successful resection of HCC or HC adenoma is excellent. In a retrospective review of 42 dogs undergoing resections of HCC’s, 2 dogs, both with right-sided tumors, died from intraoperative hemorrhage, and 2 developed distant metastases. The MST for all dogs was over 4 years.

The most common primary tumor arising from the liver in cats is hepatobiliary cystadenoma. This lesion has been referred to in the literature by a variety of names, including biliary cyst, bile duct cystadenoma, and others. It is a benign, slow-growing liver lesion that typically causes lethargy and abdominal distension in older cats. Multiple liver lobes can occasionally be involved. The prognosis with surgical removal is excellent, and because the lesion is slow-growing, even incomplete excisions can provide extended survival.

![Figure 3: Typical hepatobiliary cystadenomas](image)