

## Diagnosis of a large splenic tumor in a dog: computed tomography versus magnetic resonance imaging

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**ABSTRACT.** This study demonstrated magnetic resonance imaging (MRI) and computed tomography for large-sized splenic hemangiosarcoma. Radiography and ultrasonography revealed the presence of a large-sized soft-tissue mass in the cranial abdomen. Computed tomography showed hypoattenuating mass. The mass was located in contact with liver, spleen and stomach, and the origin of the mass remained ambiguous. The mass was T2-hyperintense and T1-hypointense with mild contrast enhancement. MRI allowed a differentiation between large-sized tumor and neighboring normal structure, and the mass was consequently identified as arising from spleen. These results suggested that MRI might be a useful tool to visualize large-sized splenic tumors and improve the accuracy of diagnosis.

**KEY WORDS:** canine, computed tomography, hemangiosarcoma, large-sized tumor, magnetic resonance imaging

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Hemangiosarcoma is the most prevalent malignant splenic tumor in dogs [9]. Patients with hemangiosarcoma tend to be diagnosed after the tumor grows fairly large, because the clinical signs are vague and nonspecific in the early stages. In patients with advanced large-sized hemangiosarcoma, increased opacity of the spleen, lack of serosal detail and displacement of other organs commonly appear on abdominal radiography [4]. Ultrasonographic findings are poorly defined, mixed echogenic (ranging from anechoic to hyperechoic), target-like or complex appearance of spleen [8, 10]. These general imaging techniques have been used traditionally to evaluate abdominal masses including splenic tumors. However, when a mass grows too large, pressing upon the neighboring structures, its origin may be difficult to determine.

The introduction of computed tomography (CT) and magnetic resonance imaging (MRI) has offered three-dimensional visualization of anatomical structures, contributing to advancements in clinical practice. The accuracy of imaging diagnosis has been greatly improved with the development of CT and MRI [4]. While CT is now widely used and studied in veterinary diagnostic imaging practice, MRI is primarily applied to the central nervous system. A previous study demonstrated that MRI is superior to contrast-enhanced CT for the detection and characterization of splenic lesions in human patients [6]. These results suggest that MRI has the

potential to increase the diagnostic accuracy of splenic tumors in dogs. However, only a few studies have reported the use of MRI in the assessment of splenic lesions in veterinary medicine [1, 7]. The objectives of this study were to describe MRI and CT characteristics of a large-sized splenic tumor in a dog diagnosed with hemangiosarcoma.

An 11-year-old, spayed, female poodle dog, weighing 5.3 kg, with a history of intermittent vomiting and anorexia for several months was referred. On physical examination, subcutaneous congestion with a palpable mass was noted in the abdomen, and the oral mucosa was pale. Complete blood count revealed anemia (hemoglobin level, 12.1 g/dl; hematocrit, 37.4%), thrombocytopenia (36,000/ $\mu$ l, reference range 200,000–460,000/ $\mu$ l) and leukocytosis (14,000/ $\mu$ l, reference range 6,000–12,000/ $\mu$ l). Serum biochemistry analysis revealed slightly elevated total bilirubin, alanine transaminase and total protein levels. Plasma D-dimer level was elevated (>2.0  $\mu$ g/ml), implying fibrinolysis or hemostasis. The other parameters were within normal range.

Radiography revealed a large-sized mass with soft-tissue opacity in the cranial abdomen, caudodorsal to the liver (Fig. 1). There was loss of serosal detail in this region; the liver was enlarged, with radiopaque material in gallbladder. The fundus of the stomach was displaced cranially and ventrally, and the body of the stomach was moved to the right. There were no significant findings on thoracic radiographs. On ultrasonographic examination, the large-sized abdominal mass with heterogeneous echo pattern was identified between liver and spleen. Although the mass showed relatively well-demarcated margin, its origin could not be determined. The parenchyma of the liver had normal echotexture. In addition, a hypoechoic nodule (15.1  $\times$  17.5 mm) was observed in the head of spleen.

For the CT and MRI scan, anesthesia was induced using propofol (2 mg/kg intravenously) and maintained on 2%

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Fig. 1. Right lateral and ventrodorsal radiographs of the abdomen. There is a large-sized mass with soft-tissue opacity, caudodorsal to the liver. The stomach is displaced to the right, cranially and ventrally.

isoflurane. CT examinations were performed using multi-detector row CT scanner (SOMATOM Emotion, Siemens, Erlangen, Germany), with the patient in dorsal recumbency. The scanning parameters were a slice thickness of 3 mm, 135 mA, 130 kV, 145 mm field of view and craniocaudal scan direction. The matrix size was  $512 \times 512$ . Considering the patient's slow heart rate and wide scanning range of the entire abdomen including large-sized mass, early- and delayed phase postcontrast CT scans were performed after administration of an intravenous bolus of 600 mg iodine/kg iohexol (Omnipaque, Nycomed Imaging, Oslo, Norway), at a rate of 1 ml/s. The early- and delayed phase images were acquired 20 and 90 sec after injection, respectively. The mass ( $65.6 \times 50.4$  mm) was hypodense to the parenchyma of the spleen and liver with focal enhanced areas on postcontrast CT (Fig. 2B and 2C). However, the origin of the mass could not be exactly determined. Because the mass was in contact with both liver and spleen, the attenuation value difference between the two organs went unnoticed. In addition, CT revealed pulmonary metastasis, enlarged mesenteric lymph nodes and a splenic nodule.

Subsequently, an MRI scan of the cranial abdomen, including the liver and spleen, was performed using a 1.5-Tesla magnetic resonance unit (Magnetom Essenza, Siemens, Munich, Germany). A body matrix coil was used, and the patients were placed in dorsal recumbency. The matrix size was  $256 \times 256$ , and the field of view was  $145 \times 146$  mm. The thickness of the slices for all sequences was 5 mm, and transverse T1-weighted (T1W), T2-weighted (T2W) and fluid-attenuated inversion recovery images were obtained. Postcontrast T1W images were acquired after administration of gadodiamide (Omniscan, Nycomed Imaging). The location and size of the mass estimated by MRI were approximately equal to those of the CT. The mass arose from the splenic head bordering the displaced stomach. This splenic mass had heterogeneously high signal intensity on T2W images and intermediate signal intensity, lower than that of parenchyma of the spleen on T1W images (Fig. 3A and 3B). On postcontrast T1W images, the splenic mass showed

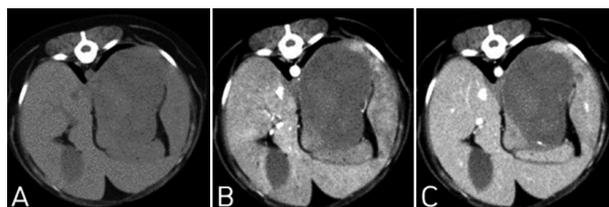


Fig. 2. Transverse CT images of abdomen (WW: 300, WL: 40). The mass appears nearly isodense to the parenchyma of spleen and liver (A) with focal mild contrast enhancement on early phase (B) and delayed phase (C).

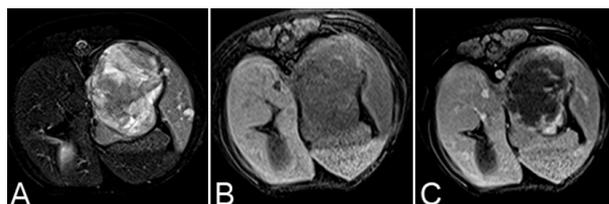


Fig. 3. Transverse MRI of abdomen. The splenic mass is heterogeneous and hyperintense with distinct difference contrast on T2W (A). The splenic mass has intermediate-signal intensity on T1W images (B) with mild contrast enhancement on postcontrast T1W images (C).

slightly and partially contrast enhancement (Fig. 3C). The enlarged lymph nodes in the mesentery and the nodule of splenic head were also identified. Based upon the CT and MRI findings of a heterogeneous large-sized mass originating from the spleen and accompanying metastases to the lungs and abdominal lymph nodes, a hemangiosarcoma of spleen was at the top of the differential diagnosis list. After splenectomy, the excised splenic tumor was histologically diagnosed as hemangiosarcoma (Fig. 4), and the patient was in remission during 3 months of follow-up.

Hemangiosarcoma is a malignant vascular tumor with high metastatic potential [9]. For hemangiosarcoma treatment and prognosis, evaluation of metastasis and complete excision of the lesion is important. Abdominal ultrasonography has been commonly used as a conventional imaging modality for evaluation of abdominal organs in veterinary medicine. However, there are difficulties in imaging the entire spleen of patients with splenomegaly and limitations to the correct evaluation of origin [3]. The sensitivity of ultrasonography in differentiating a malignant- from a non-malignant mass is poor, because both types of masses tend to vary in echogenicity and appearance [3]. Contrast harmonic ultrasonography is not useful in distinguishing splenic hemangiosarcoma from nonmalignant mass, either [5].

CT has a better ability to evaluate the large-sized splenic mass than ultrasonography. CT differentiates tissues by their attenuation value, which is related to the density and chemical composition of the tissue. Therefore, it is possible to distinguish a malignant- from a nonmalignant mass [2]. A previous study demonstrated that malignant canine splenic

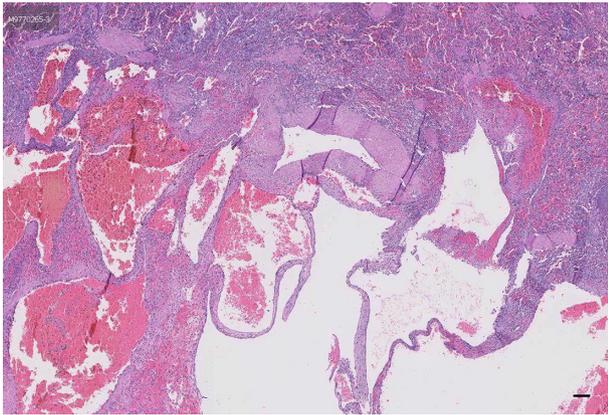


Fig. 4. Histopathological section of the splenic mass. Poorly demarcated mass composed of multiple variably sized blood-filled channels lined by neoplastic endothelium. HE stain. Bar=200  $\mu$ m.

masses have lower attenuation values than nonmalignant masses on non- and postcontrast CT images, probably correlating to presence of a large hematocyst in association with splenic hemangiosarcoma [2]. In this study, attenuation values of the splenic hemangiosarcoma were heterogeneously distributed from 20 to 60, which corresponded to the results of the previous study. However, the margin of the mass was ambiguous, and the origin of the mass was not easily recognized for two reasons: first, the large-sized mass was in contact with all adjacent structures, such as spleen, liver and displaced stomach. Second, the differences in the attenuation value between these structures were not significant on CT images.

MRI is the most promising noninvasive imaging modality. It is considered to have contrast resolution to the other imaging modalities, although CT provides better spatial resolution. Especially in the localization and assessment of the soft tissue mass, MRI discriminates subtle differences among soft tissues and displays better contrast than CT between mass and soft tissues. The splenic hemangiosarcoma is hyperintense on T2W MRI and hypointense on T1W MRI [1]. If the signal intensity on both T1W and T2W sequences is low, it probably reflects hemorrhagic necrosis or siderotic nodules. Hyperintense region on both T1W and T2W images possibly corresponds to late subacute hemorrhage [2]. In our study, the splenic hemangiosarcoma was heterogeneously hyperintense, and the liver was hypointense on T2W images. On T1W images, the splenic mass showed intermediate signal intensity lower than that of splenic and hepatic parenchyma. On postcontrast T1W images, the splenic mass showed lower signal than normal splenic parenchyma and mildly

peripheral enhancement with indistinct borders, supporting the presence of a solid pathologic structure. Contrary to CT and other imaging modalities, the margin between the spleen and liver was obviously identified with further contrast. The mass, splenic parenchyma and liver were well distinctive, especially on T2W and postcontrast T1W images. The nodule was T2-hyperintense and T1-isointense with no contrast enhancement.

In conclusion, postcontrast MRI was superior to CT in terms of soft-tissue resolution of the splenic tumor. T2W MRI and postcontrast T1W MRI were useful in evaluating a large-sized splenic tumor. This study suggests that introduction of MRI might help to improve the preoperative diagnostic accuracy in patients with large-sized splenic tumors.

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