Incidence of malignancy and outcomes for dogs undergoing splenectomy for incidentally detected nonruptured splenic nodules or masses: 105 cases (2009–2013)

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OBJECTIVE
To determine the frequency of malignancy and survival rates of dogs that underwent splenectomy for incidentally detected nonruptured splenic masses or nodules.

DESIGN
Retrospective case series.

ANIMALS
105 client-owned dogs.

PROCEDURES
Medical records of dogs that underwent splenectomy at a veterinary teaching hospital between 2009 and 2013 were examined to identify patients with incidentally detected nonruptured splenic masses or nodules without associated hemoperitoneum. Only dogs with histologically confirmed diagnoses were included. Information regarding signalment, preoperative diagnostic tests, perioperative blood product transfusions, splenic mass diameter, histologic findings, adjunctive treatments, and survival time was collected and analyzed.

RESULTS
74 of 105 (70.5%) patients had benign splenic lesions and 31 (29.5%) had malignant neoplasia, most commonly hemangiosarcoma (18/31 [58%]). The hazard of death decreased as preoperative PCV increased; histopathologic diagnosis of malignant neoplasia was significantly associated with an increased hazard of death. Median life expectancy of dogs with benign and malignant lesions was 436 and 110 days, respectively; 41 of 74 patients with benign lesions and 3 of 31 patients with malignant neoplasia were still alive at study conclusion. Median life expectancy of dogs with hemangiosarcoma was 132 days; only 7 of these 18 dogs received any adjunctive chemotherapeutic treatments.

CONCLUSIONS AND CLINICAL RELEVANCE
Incidentally found, nonruptured splenic masses or nodules without associated hemoperitoneum were most commonly benign. Results suggested that life expectancy for these dogs with incidentally detected benign or malignant splenic lesions that received prompt intervention was better than has previously been reported for other studied populations. (*J Am Vet Med Assoc* 2016;248:1267–1273)

Splenic abnormalities are commonly diagnosed in canine patients. Splenomegaly attributable to masses, nodules, diffuse disease, vascular obstruction, or malpositioning can be identified by palpation, abdominal ultrasonography, radiography, and other more advanced imaging modalities. Pathological splenic changes may be identified incidentally during routine examination of a dog without associated clinical signs or in a patient evaluated for nonspecific signs such as vomiting, inappetence, or unexplained weight loss.

ABBREVIATIONS

CI	Confidence interval
FNA	Fine-needle aspirate
HR	Hazard ratio

Some of the most commonly observed signs are secondary to a diagnosis of hemoperitoneum from splenic mass rupture. Pathological changes of the spleen with associated hemoperitoneum have been extensively described, with an emphasis on hemangiosarcoma and other malignant neoplastic lesions. Studies[1–4] have found the frequency of malignant splenic masses to be as high as 241 of 500 (48%) to 59 of 100 (59%). These data are important to help owners decide whether to pursue surgical treatment for their pet. Splenectomy is typically performed as primary treatment and as a means of allowing definitive diagnosis for patients with splenic disease. Given the reported rates of hemangiosarcoma in dogs with splenic masses (diagnosed in 30/65 [46%] dogs in one study[5] and 50/54 [93%]

dogs in another[6]) and reports indicating median survival times of 57 to 86 days for dogs with hemangiosarcoma treated by surgery alone,[6,7] owners may not elect to proceed with surgery.

Investigators have evaluated and provided multiple prognostic indicators to help better understand the likelihood of malignancy in dogs with splenic disease. Hemoperitoneum, mass size, mass rupture, anemia, and thrombocytopenia at the time of diagnosis have been shown to be predictive of malignancy.[1,2] Rupture of splenic masses with subsequent hemoperitoneum has been associated with a 63% to 76%[5,6,8] rate of malignancy, with hemangiosarcoma reported as the most common malignancy. Splenic mass-to-patient size ratios have been analyzed, with 1 study[5] finding that dogs with benign splenic masses had a significantly higher mean splenic weight (as a percentage body weight) than did dogs with hemangiosarcoma. Additional studies have evaluated use of contrast-enhanced abdominal ultrasonography,[9] ultrasound-guided FNAs,[10] and contrast-enhanced CT imaging[11] in attempts to find nonsurgical diagnostic tools to help differentiate between benign and malignant splenic lesions. To the authors' knowledge, no such test has been identified that is a highly sensitive and specific predictor of malignancy. Previous studies have included dogs with and without hemoperitoneum, and a literature search identified no studies in which dogs with splenic masses or nodules without evidence of rupture and hemoperitoneum were evaluated as an isolated group. A ruptured and bleeding mass has been shown to be prognostic for malignancy, leaving the presumption that a nonruptured mass is less likely to be malignant.[5,6,8] The purpose of the study reported here was to identify dogs with incidentally identified splenic abnormalities described as nonruptured masses or nonruptured nodules and no concurrent hemoabdomen attributed to splenic bleeding and to determine the frequency of malignancy and survival times for these patients following splenectomy. We hypothesized that the frequency of malignancy in dogs with nonruptured masses and or nodules without concurrent hemoperitoneum would be lower than that described in studies that did not evaluate such dogs separately. We further hypothesized that median survival times for these dogs would be longer than those previously described for dogs with splenic disease when rupture and splenic hemorrhage were not causes for exclusion.

Materials and Methods

Case selection

Electronic medical records of the Angell Animal Medical Center were searched to identify dogs that underwent a partial or complete splenectomy as treatment for incidentally found splenic masses or nodules between November 1, 2009, and December 31, 2013. To be included in the study, a patient was required to have a complete medical record including a surgery report, ultrasonography report, client communication record, or discharge instructions detailing that no rupture of the mass or nodule or hemoperitoneum attributed to splenic hemorrhage was noted at surgery. Additional inclusion criteria included submission of the excised tissue for histologic examination and a completed histopathology report. Patients with ultrasonographic or surgical records that described a scant or small amount of anechoic or serosanguinous ascites were included if this was not attributed to splenic bleeding. Patients with multiple splenic masses or nodules were also included. Findings of mass or nodule rupture, generalized splenomegaly without evidence of a mass or nodule, splenic torsion, splenic vasculature disruption by rupture owing to gastric dilatation-volvulus or by thrombotic obstruction, or traumatic splenic rupture were causes for study exclusion. Records were also excluded if splenectomy was performed because of systemic immune-mediated disease (eg, immune-mediated thrombocytopenia).

Medical records review

Data obtained from the electronic medical records included patient age, breed, sex, body weight, reason for evaluation, clinical signs, preoperative PCV (if a PCV was not available, Hct was recorded and was treated as equivalent to PCV in value), and serum total solids concentration (if a total solids value was not available, total protein concentration was recorded and treated as equivalent to a total solids value). Results of diagnostic evaluations, including abdominal and thoracic radiography, CT, abdominal ultrasonography, and echocardiography, were also recorded. Ultrasonography was performed by board-certified radiologists, and the ultrasonographic echogenicity of the mass or nodule (heterogeneous [ie, multiple echogenicities noted or cavitary appearance of the lesion] or homogeneous [single echogenicity observed]) was recorded as written in the radiology reports when available. Additionally, the specific echogenicities (isoechoic, hypoechoic, or hyperechoic) were recorded as written in the radiology reports. More than 1 echogenicity could be recorded for individual or multiple masses. Echogenicity was defined by comparison with the remaining normal splenic parenchyma because the lesions were focal nodules and masses within the normal splenic parenchyma. Also recorded was whether an FNA was obtained during ultrasonography and whether cytologic diagnosis corresponded to the histologic findings. Whether a perioperative transfusion was administered, how a mass or nodule was identified, date of mass or nodule diagnosis, surgery date, and tissues biopsied were additionally recorded. The estimated diameter of splenic nodules or masses was collected from surgery reports or ultrasound recordings; if multiple measurements or multiple lesions were identified, the largest diameter was used. Number of masses or nodules identified; results of histologic examination; tumor stage[12] and presence of metastasis, if applicable; and whether patients with

malignant tumors underwent chemotherapy were also recorded. All histologic examinations were performed by 1 board-certified pathologist. Survival data were determined by reviewing records for euthanasia dates or last date of patient examination or owner contact at the study facility; where applicable, primary care veterinarians were contacted to obtain dates of euthanasia or spontaneous death or the date of last follow-up with the owners. Manner of death was not recorded.

Statistical analysis

Data were summarized as median and range or number and percentage for continuous or categorical measures, respectively. Wilcoxon 2-sample and χ^2 tests were implemented for continuous and categorical variables, respectively, for assessment of differences in distributions between dogs grouped by diagnosis (eg, malignant vs benign disease), except that a Fisher exact test was implemented in instances when any contingency table expected cell counts were < 5. Malignancy was defined as histopathologic findings consistent with any malignant splenic tumor. Unadjusted HRs and 95% CIs were calculated via proportional hazards regression. Initial variables were selected and included for their hypothesized biological relationships with malignancy and death. In addition to malignancy, candidate predictors for multivariable time to event (death) analyses included all variables associated with both malignancy and death in unadjusted bivariate analyses. Adjusted HRs and 95% CIs were calculated for predictors of interest including malignancy, osteosarcoma, hemorrhage, and PCV (as a continuous variable). Since malignancy, hemangiosarcoma, and metastasis were all highly correlated, the latter 2 variables were excluded as predictors in multivariate analyses. Patients were censored by their last date of contact during the proportional hazards analysis. Because cause of death was not recorded, no patients that died during the study period were censored. A Kaplan-Meier survival analysis was performed. All analyses were performed with commercially available software.[a] Values of $P < 0.05$ were considered significant.

Results

Records screening identified 213 dogs that underwent splenectomy during the study period; of these, 108 were excluded because of a diagnosis of a hemoperitoneum attributed to splenic bleeding, splenic mass rupture, splenic torsion, or generalized splenomegaly without evidence of nodules or masses. One hundred five canine patients met the criteria for study inclusion, including 1 dog that had hemoperitoneum caused by gastric hemorrhage. There were 60 spayed females, 42 castrated males, and 3 sexually intact females. Mixed-breed dogs were most commonly represented (24/105 [22.9%]), followed by Golden Retrievers (10 [9.5%]), Labrador Retrievers (9 [8.6%]), German Shepherd Dogs (5 [4.8%]), Jack Russell Terriers (5 [4.8%]), Standard Poodles (4 [3.8%]), Dachshunds (4 [3.8%]), and Tibetan Terriers (3 [2.9%]). There were 2 (1.9%) patients each of Bassett Hound, Beagle, Bichon Frise, Boston Terrier, Pug, Rottweiler, Shiba Inu, and Shih Tzu breeds and 1 each of 25 (1%) other purebreds. Median age and weight at time of diagnosis were 11.0 years (range, 9.4 to 12.4 years) and 22.5 kg (49.5 lb; range, 12.1 to 31.8 kg [26.6 to 70.0 lb]), respectively. Thirty-one dogs had a diagnosis of malignant neoplasia, and 74 had benign splenic lesions.

The median PCV and serum total solids concentration prior to surgery were 40.6% (range, 33% to 46%) and 7 g/dL (range, 6.3 to 7.5 g/dL), respectively. Patients with benign lesions had a significantly ($P = 0.02$) higher median PCV (42.4%; range, 34% to 47.7%) before surgery than did those with malignant neoplasia (37%; range, 32% to 41.5%). Thirty-nine of 105 (37%) patients were anemic (ie, PCV below the reference range [37% to 55%]) in the preoperative period (defined as 96 hours prior to surgery); this included 15 of 31 (48%) dogs with malignant and 24 of 74 (32%) dogs with benign splenic lesions ($P = 0.123$). There was no significant ($P = 0.938$) difference in median serum total solids concentration between patients with benign (6.8 g/dL; range, 6.3 to 7.5 g/dL) and malignant (7.1 g/dL; range, 6.4 to 7.6 g/dL) lesions. Five of the 105 (5%) dogs were hypoproteinemic (ie, total protein concentration below the reference range of 5.4 to 7.0 g/dL) in the preoperative period, including 1 of 31 (6%) dogs with malignant lesions and 3 of 74 (4%) dogs with benign splenic lesions ($P = 0.631$). Four dogs were both anemic and hypoproteinemic, but were evenly distributed between the 2 disease groups and too few in number for statistical comparisons. The median recorded diameter of splenic masses or nodules was 7 cm (range, 4 to 10 cm), that for dogs with benign lesions was 6.25 cm (range, 4 to 10 cm), and that for dogs with malignant lesions was 8 cm (range, 6 to 10 cm; $P = 0.182$).

Thoracic radiographs, abdominal radiographs, and abdominal ultrasound images were obtained preoperatively in 93 (88.6%), 58 (55.2%), and 95 (90.5%) of 105 patients, respectively, with most patients evaluated by > 1 modality. Two (1.9%) dogs underwent CT imaging (thoracic and abdominal CT in one and abdominal CT in the other). Ultrasonographic echogenicity of the splenic masses was recorded for 88 of the 95 dogs evaluated with this method, with 57 (65%) and 31 (35%) identified as heterogenous and homogenous, respectively. Of these 88 dogs, 18 (20%) with malignant lesions and 39 (44%) with benign lesions had heterogeneous echogenicity, whereas 11 (13%) with malignant lesions and 20 (23%) with benign lesions had homogeneous echogenicity. Lesion echogenicity was analyzed as a predictor of malignant neoplasia, with heterogenous lesions identified in 18 of 29 (62%) dogs with malignant and 39 of 59 (66%) dogs with benign lesions ($P = 0.582$). Homogenous lesions were identified in 11 of 29 (38%) and 20 of 59 (34%) dogs with malignant and benign lesions, respectively ($P = 0.371$). Ultrasonography reports denoted an isoechoic

mass in 1 of 29 (3%) and 11 of 59 (19%) patients with malignant and benign lesions, respectively ($P = 0.103$). Hyperechoic splenic masses were recorded for 3 of 29 (10%) and 6 of 59 (10%) patients with malignant and benign masses, respectively ($P = 0.720$). Splenic masses recorded as hypoechoic were identified in 12 of 29 (41%) and 13 of 59 (22%) dogs with malignant and benign lesions, respectively; the frequency of any hypoechoic mass or nodule was significantly ($P = 0.02$) greater for dogs with than without malignant lesions.

No significant difference was found between dogs with malignant versus benign masses or nodules when the means of initial (incidental) identification (eg, abdominal palpation, radiography, ultrasonography, or surgery) were compared. Twelve dogs had ultrasound-guided FNAs obtained, and these were examined by 1 board-certified pathologist. Identification by cytologic examination corresponded to that made histologically for 8 of the 12 dogs. Four dogs each with malignant or benign lesions had matching cytologic and histologic diagnoses. Liver biopsies were performed for 74 dogs (51 and 23 with benign and malignant lesions, respectively). Ten dogs had lymph node biopsies (8 and 2 with benign and malignant lesions, respectively).

Of the 31 dogs with malignant neoplasia, 18 (58%) had hemangiosarcoma, 3 (10%) had histiocytic sarcoma, 3 (10%) had lymphoma, 2 (6%) had a malignant fibrohistiocytic nodule (grade 3), and 2 (6%) had osteosarcoma. One (3%) dog each had leiomyosarcoma, liposarcoma, and metastatic adenocarcinoma. Eight dogs were found to have metastatic disease; this was diagnosed by examination of hepatic biopsy samples from 6 dogs (2 with hemangiosarcoma, 2 with osteosarcoma, 1 with lymphoma, and 1 with adenocarcinoma). One dog with lymphoma had metastatic disease in a gastric lymph node, and 1 dog with liposarcoma had metastatic disease diagnosed by examination of an intra-abdominal mass. Among 18 dogs with a diagnosis of hemangiosarcoma (17% of the study population), 12 had hepatic biopsies performed at the time of splenectomy, and 2 of these had metastatic disease confirmed, resulting in 10 patients with stage 1 or stage 2 disease and 2 with stage 3 disease.

Of the 74 dogs with benign splenic nodules or masses, 37 (50%) had a primary diagnosis of nodular lymphoid hyperplasia, 16 (22%) had a hematoma, 11 (15%) had focal intraparenchymal hemorrhage and necrosis, 3 (4%) had extramedullary hematopoiesis, 2 (3%) each had abscess and myelolipoma, and 1 (1%) each had hemangioma, splenitis, and a fibrohistiocytic nodule (grade 2). Five of the dogs with benign lesions (3 with nodular lymphoid hyperplasia and 2 with hematoma) were incidentally found to also have an indolent form of a marginal zone lymphoma, for which splenectomy was considered to be curative.

Median survival after splenectomy was 274 days (range, 99 to 553 days). Patients with a diagnosis of benign splenic lesions had a median life expectancy of 436 days (range, 149 to 784 days) and a 1-year survival rate of 64% **(Figure 1)**. Forty-one of the 74 patients with a diagnosis of benign splenic lesions were still alive at study conclusion; the time from surgery to the end of the study was < 1 year for 13 of these dogs. Patients that had a diagnosis of malignant neoplasia had a median life expectancy of 110 days (range, 4 to 986 days), and 3 of these 31 patients were still alive at study conclusion. Dogs that died during the study period had a median life expectancy of 185 days (range, 39 to 449 days), and death during the study period was significantly ($P < 0.05$) associated with malignancy. Patients with hemangiosarcoma (18/31 [58%] with malignant neoplasia) had a median life expectancy of 132 days (range, 4 to 986 days) and a 1-year survival rate of 16.7%. Ten of 31 (32%) patients with malignant neoplasia had received chemotherapy following surgery and diagnosis; median survival for this subset of dogs was 242 days (range, 108 to 986 days). Seven of the 10 dogs that underwent chemotherapy had hemangiosarcoma, and 1 each had large-cell lymphoma, a fibrohistiocytic nodule (grade 3), and metastatic anal sac adenocarcinoma. Four of these 7 dogs with hemangiosarcoma were treated with doxorubicin (1 mg/kg [0.45 mg/lb], IV, for 4 to 6 doses) and metronomic therapy with cyclophosphamide (1.14 mg/kg [0.52 mg/lb], PO). Two of these were additionally treated with an NSAID (carprofen; 2.2 mg/kg [1.0 mg/lb], PO). One of the remaining 2 dogs was additionally treated with chlorambucil (0.1 mg/kg [0.05 mg/lb], PO). Two of the 7 dogs underwent metronomic therapy alone with cyclophosphamide (1.6 mg/kg [0.73 mg/lb], PO) or chlorambucil (0.1 mg/kg, PO) and an NSAID (piroxicam; 0.3 mg/kg [0.14 mg/lb], PO); the remaining dog received only 1 dose of doxorubicin because of a poor reaction to initial treatment. Median life expectancy of the 7 dogs that underwent chemotherapy for hemangiosarcoma was 223 days (range, 108 to 986

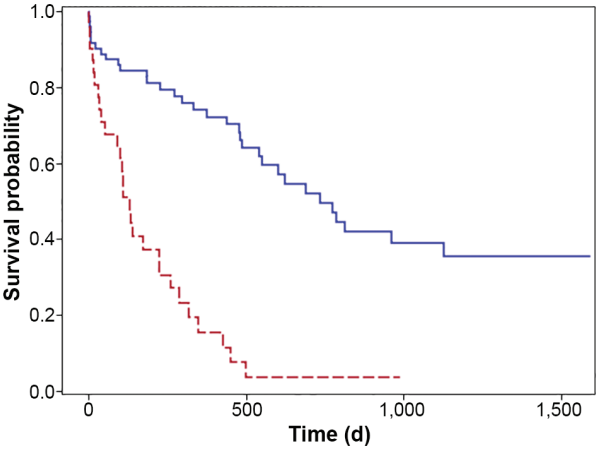

Figure 1—Kaplan-Meier survival plot depicting survival time in days from splenectomy to date of death or last follow-up for 105 dogs with incidentally detected splenic masses or nodules (31 with malignant neoplasia [dashed red line] and 74 with benign lesions [solid blue line]) in a retrospective study. Life expectancy was significantly ($P < 0.001$) greater for dogs with benign lesions than for those with malignancy.

days), and the 11 dogs with hemangiosarcoma that underwent only surgery had a median life expectancy of only 104 days (range, 4 to 449 days). The 4 dogs treated with full-course doxorubicin and metronomic therapy had a median life expectancy of 242 days (range, 108 to 986 days). The 3 dogs that had large cell lymphoma, a fibrohistiocytic nodule (grade 3), or metastatic anal sac adenocarcinoma and received chemotherapy were treated with prednisone (administered orally; dosing regimen not available), lomustine (2.9 mg/kg [1.3 mg/lb], PO), and mitoxantrone (0.16 mg/kg [0.07 mg/lb], IV for 3 doses), respectively. Comparisons of survival times among dogs with specific neoplasms were not conducted owing to very small group sizes for some and various modes of treatment for the patients with hemangiosarcoma.

The unadjusted HR analysis to identify associations between malignancy and death identified several significant factors, including histologic diagnosis of a malignant tumor (HR, 4.68; 95% CI, 2.71 to 8.07; $P < 0.001$), diagnosis of osteosarcoma (HR, 6.97; 95% CI, 2.05 to 23.7; $P = 0.002$), diagnosis of (benign lesion) intraparenchymal hemorrhage and necrosis (HR, 0.23; 95% CI, 0.05 to 0.93; $P = 0.039$), and preoperative PCV (modeled as a continuous variable; HR, 0.95; 95% CI, 0.92 to 0.98; $P = 0.001$). When these variables were adjusted, excluding metastatic disease and hemangiosarcoma, results were as follows: the hazard of death was significantly increased for dogs with a histopathologic diagnosis of a malignant tumor (HR, 4.23; 95% CI, 2.39 to 7.55; $P < 0.001$), compared with dogs that had other diagnoses, and decreased for dogs with a higher PCV (HR [expressed for each 1-unit increase in PCV], 0.95; 95% CI, 0.92 to 0.98; $P = 0.002$). Associations with death were no longer significant for a diagnosis of osteosarcoma (HR, 2.14; 95% CI, 0.61 to 7.58; $P = 0.237$) or diagnosis of intraparenchymal hemorrhage and necrosis (HR, 0.41; 95% CI, 0.10 to 1.72; $P = 0.221$).

Discussion

In the present study, dogs that had splenic masses or nodules without associated hemoperitoneum more commonly had benign (74/105 [70.5%]) than malignant (31/105 [29.5%]) lesions. Hemangiosarcoma was identified in 18 of 31 (58%) dogs with malignant neoplasia, and this frequency was lower than that found in previous studies,[1,5] in which hemangiosarcoma represented 43 of 59 (73%) to 30 of 40 (75%) malignant splenic tumors. The lower frequency of hemangiosarcoma in the present study may have been attributable to inclusion of dogs with nonruptured splenic masses or nodules only, suggesting that hemangiosarcomas are more likely to rupture and bleed prior to diagnosis than are other malignant splenic tumors. The median life expectancy of dogs with a diagnosis of stage 1 or 2 hemangiosarcoma that survived ≥ 7 days after splenectomy and did not have adjuvant chemotherapy was 86 days in a retrospective study[7] of 32 dogs. Additionally, 1-year survival rates of 6.3% to 7% have been reported for dogs with hemangiosarcoma treated by surgery alone.[5,7] In the present study, dogs with hemangiosarcoma had a median life expectancy of 132 days and a 1-year survival rate of 16.7%. When dogs that received adjuvant chemotherapy for hemangiosarcoma (7/18) were eliminated from the analysis along with 1 patient that died within 4 days after surgery, median life expectancy for the remaining 10 dogs treated by surgery only was 117.5 days. This life expectancy was still longer than previously reported in a comparable group of dogs.[7] The difference in survival rates could be attributable to the smaller population size in the study, differences in breed distribution, and earlier recognition of the splenic lesions without concurrent hemoperitoneum. Early detection and treatment may limit development of microscopic metastasis and result in longer median life expectancy. Presumably, with lesser metastatic progress, chemotherapy may be more effective at slowing the progression of disease in dogs with nonruptured masses. For the 7 patients that underwent splenectomy and chemotherapy for treatment of hemangiosarcoma, the median life expectancy was 223 days. Although this was 119 days longer than the median value for the 11 dogs with the same diagnosis that underwent surgery alone (104 days), the small number of patients prevented statistical analysis.

Both the lower proportion of dogs with malignant neoplasia and increased life expectancy following a diagnosis of hemangiosarcoma in the present study, compared with the previously reported findings, supported the concept that dogs with incidentally identified splenic masses or nodules without associated hemoperitoneum may have a better long-term prognosis following splenectomy (with or without adjunctive chemotherapy) than dogs that have developed clinical signs of the disease. This is in agreement with findings in a previous study,[13] in which hemoperitoneum was found to be a negative prognostic indicator in dogs with splenic hemangiosarcoma. Results of another study[14] revealed that hemoperitoneum was more than twice as common in dogs with splenic hemangiosarcoma as in those with splenic hematoma and that the presence of nodular lymphoid hyperplasia was unlikely to be associated with hemangiosarcoma. Those results[14] were in agreement with the high proportion of benign splenic lesions diagnosed in the present study and supportive of the notion that identification of nodular lymphoid hyperplasia in 37 of 74 (50%) dogs with benign lesions helps reduce the concern that hemangiosarcoma was potentially underdiagnosed. In 1 preliminary study[15] of 21 dogs with splenic hemangiosarcoma, adjuvant chemotherapy (initiated ≤ 3 weeks after splenectomy) appeared to improve survival, compared with results for dogs that underwent splenectomy alone in an earlier study.[7] Early chemotherapy following surgical treatment of malignant splenic lesions should be considered.

In the authors' experience, splenectomy is generally well-tolerated by dogs and recovery after surgery is typically short (10 to 14 days). Minimally invasive laparoscopic procedures have become more popular in recent years, with investigators reporting low-

er morbidity rates, shorter duration of hospital stay, lower postoperative pain scores, and reduction in incision lengths, depending on patient size and organ size to be removed.[16,17] Whereas patients with bleeding splenic tumors often require emergency surgery, those without hemoperitoneum are inherently more stable; therefore, an elective laparoscopic splenectomy can be considered. However, the extent or diameter of splenic masses may affect the ability to successfully perform a laparoscopic procedure because greater celiotomy length may be required for splenectomy in dogs with large or multiple masses. The median diameter of masses or nodules in the present study was 7 cm, which may translate to a similar celiotomy length. Preoperative measurements by ultrasonographic or CT examination may help to accurately determine splenic mass diameter and whether a minimally invasive procedure would be beneficial.[16,18] Splenic nodules or masses, while more commonly benign in dogs of the present study, still have the potential to progress and rupture, causing a destabilizing condition of hemoperitoneum. In a previous study,[5] hemoperitoneum was present in 14 of 25 (56%) dogs with benign splenic masses. Mass rupture with subsequent hemoperitoneum progression worsens the perioperative complication and survival rates[8]; therefore, we recommend that intervention be considered for any focal pathological splenic lesion.

Preoperative diagnostic findings were evaluated in this study in an attempt to better provide information on differentiating between benign and malignant splenic masses or nodules. Ultrasonography is a noninvasive diagnostic tool that can allow characterization of a splenic mass, including its size and echogenic characteristics, as well as assessment for presence of ascites and evidence of metastatic disease. In this study, ultrasonographic echogenicity of splenic lesions was recorded for 88 of the 95 dogs that underwent preoperative abdominal ultrasonography; comparison of characteristics between lesions later identified as benign and malignant revealed that 12 of 29 (41%) malignant tumors were reported to appear hypoechoic, which was a significantly greater frequency than the 13 of 59 (22%) benign tumors that had this finding.

Use of ultrasound-guided FNAs for a diagnosis of splenic lesions is controversial. Concerns include potentially seeding malignant neoplastic cells into the body wall or peritoneal cavity or causing hemoperitoneum and subsequent decompensation of a stable patient through rupture of a cavitated mass. Additionally, reports on the accuracy of cytologic versus histologic findings vary substantially. Investigators of an early study[10] of 33 small animals with splenomegaly found that results corresponded between the 2 diagnostic methods for 14 of 14 patients. Christensen et al[19] found complete agreement between cytologic and histologic findings in 10 of 17 dogs with splenic disorders, aligning more closely with the results found in our study (8/12). The diagnoses in agreement and disagreement between methods in the present study were evenly distributed between dogs with benign and malignant lesions. Although there are concerns for complications following ultrasound-guided FNA, patient selection, clinician experience, and ultrasonographic appearance of splenic lesions may be factors that influence whether potential benefits of information obtained by this method may justify the associated risk. Because of the low number of patients that had the procedure performed in the present study, recommendations regarding its utility in various situations could not be made and this warrants further study.

Although analysis of preoperative hematologic values identified a significantly higher median PCV (42.4%) in patients with benign lesions than in those with malignant neoplasia (37%), serum total solids concentrations and the frequencies of anemia and hypoproteinemia did not differ between these 2 groups. This was in contrast to results of another study[6] that found no significant difference in mean PCV at hospital admission between dogs with hemangiosarcoma and those with benign splenic lesions, but identified a significantly lower mean total solids concentration in the dogs with hemangiosarcoma. However, that study[6] analyzed data for patients with hemoperitoneum, making interpretation of apparent differences difficult.

Splenic mass or nodule diameters (largest diameter of a solitary lesion or largest of multiple lesions) determined from diagnostic imaging or surgical records were analyzed in the present study and did not differ between dogs with malignant and benign conditions. Results of a previous investigation[5] suggested that mass-to-splenic volume ratio and splenic weight as a percentage of patient body weight could be useful in differentiating benign splenic lesions from splenic hemangiosarcoma in dogs; however, comparable data were not assessed in our study.

Limitations of the study reported here were inherent of a retrospective study. The survival data were only collected via communication with the primary care veterinarian on record and relied on their last-known contact with the dog and owner. Some of these last-known contacts were for medication refills, food refills, or follow-up by telephone on patient status as listed in the medical records. Additionally, although the study was performed for evaluation of incidentally found splenic masses or nodules, some patients did have nonspecific clinical signs that were most likely secondary to an intraperitoneal mass effect. Dogs are frequently evaluated on an emergency basis because of nonspecific signs or are brought to clinics for annual checkup examinations with nonspecific signs, and are not found to have splenic masses. Such patients were included in this study if no splenic rupture or hemoperitoneum was noted. Additional limitations of the study include the small numbers, both of total patients in the study and of those with hemangiosarcoma.

Our results suggested that life expectancy for dogs with incidentally detected benign or malignant splenic lesions that had prompt intervention was better than has previously been reported for other stud-

ied populations. In these dogs, the hazard of death was decreased as preoperative PCV increased, and histopathologic diagnosis of a malignant tumor was significantly associated with an increased hazard of death. Further research, including larger numbers of dogs, is warranted.

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Footnotes

a. SAS, version 9.3, SAS Institute Inc, Cary, NC.

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