PAPER

Sonographic features of gastrointestinal lymphoma in 15 dogs

M. Frances, A. E. Lane* and Z. M. Lenard

*Perth Veterinary Oncology, Osborne Park, Western Australia, Australia

Department of Radiology, Veterinary Imaging Centre, Osborne Park, Western Australia, Australia

Objectives: The purpose of this study is to describe the sonographic appearance of lymphoma of the gastrointestinal tract in dogs.

Method: A retrospective review was conducted and patients with gastrointestinal lymphoma diagnosed by histopathology (including immunohistochemistry, where available) or cytology that had an abdominal ultrasound were included.

Results: Four of 15 (26·7%) cases with histopathologically confirmed lymphoma exhibited no sonographic abnormalities. In the dogs with sonographic abnormalities, features including intestinal wall thickness and the presence or absence of wall layering were highly variable. Clinical signs pertaining to the gastrointestinal tract were also unreliable markers of gastrointestinal lymphoma, with weight loss, vomiting, and diarrhoea being uncommon presenting complaints; intestinal obstruction was not present in any patient.

Clinical Significance: The sonographic appearance of gastrointestinal lymphoma in dogs is non-specific. Gastrointestinal lymphoma in dogs should be maintained as a differential diagnosis despite a sonographically normal appearing bowel.

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INTRODUCTION

In the cat, sonographic features of lymphoma include thickening of the stomach and intestinal wall, loss of the normal layered appearance, the presence of a hypoechoic mass associated with the gastrointestinal tract and abdominal lymphadenopathy. Thickening of the muscularis propria has been significantly associated with T-cell lymphoma in cats (Zwingenberger *et al.* 2010). In dogs, comparisons have been made between sonographic features of common intestinal tumours (e.g. adenocarcinoma, leiomyoma, leiomyosarcoma) and non-neoplastic disease, including inflammatory bowel disease and enteritis, (Penninck *et al.* 1990, Grooters *et al.* 1994, Myers & Pennink 1994, Graham *et al.* 2000, Penninck *et al.* 2003, Rudorf *et al.* 2005). Specific comparisons have been made between sonographic features of canine gastric lymphoma and other types of gastric neoplasia, (Lamb *et al.* 1999), but features of canine gastrointestinal lymphoma remain poorly described. The purpose of this study was to describe the sonographic appearance of lymphoma of the gastrointestinal tract in a series of 15 dogs.

MATERIALS AND METHODS

A retrospective review of the medical records of patients presented to two specialist referral hospitals (Veterinary Imaging Centre and Murdoch University) between the years of 2008 and 2011 was performed using the search terms "lymphoma", " intestine", "gastric", "stomach", "neoplasia", "gastrointestinal" and "GIT" (gastrointestinal tract). Cases were included if they had a complete abdominal ultrasound by a specialist veterinary radiologist and a diagnosis of lymphoma made by histopathology or cytology from the gastrointestinal lesion. Patients were excluded if the diagnosis was made based on cytology from a regional lymph node alone. Signalment, history (including the presence of concurrent disease) and presenting clinical signs were reviewed.

For each patient, ultrasound reports and corresponding images (where available) were reviewed by the primary author and each region of the intestinal tract (stomach, small intestine, large intestine) was evaluated. Lesions were classified as structurally normal or abnormal. In abnormal segments of intestine, the abnormalities were further categorised as being focal (occurring in one place in the region), multifocal (occurring in multiple places through

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the region), or diffuse (affecting the entire region). The presence or absence of regional lymphadenopathy was recorded.

Wall architecture including wall thickness (normal; or mild, moderate or severe thickening), wall layering (normal, present but altered, effaced) and echogenicity (normal, predominantly hypoechoic, predominantly hyperechoic or heterogeneous/complex) was assessed. The presence or absence of gastric or intestinal obstruction was noted.

Normal thickness of the gastrointestinal wall segments was assessed according to previously published criteria (Penninck *et al.* 1989, Delaney *et al.* 2003). Normal gastric wall was considered to be ≤5 mm. Normal thickness for the duodenal wall was considered ≤5·1 mm for dogs <20 kg, ≤5·3 mm for dogs 20-29·9 kg, and ≤6 mm for dogs >30 kg. Normal jejunal wall thickness was ≤4·1 mm for dogs <20 kg and ≤4·4 mm for dogs 20-40 kg. Normal thickness for the colon wall was considered to be ≤3 mm. Mild thickening for all regions was defined as up to 8 mm, moderate thickening as between 8 and 20 mm, and severe thickening as >20 mm.

Wall layering was assessed subjectively and was defined as being present but altered if the normal intestinal wall layers (mucosa, submucosa, muscularis or serosa) were identifiable as being well-defined and separate from one another, but the relative thickness or echogenicity of one or more layers was abnormal.

Gastric outflow obstruction was considered to be present if there was severe and/or persistent dilation of the gastric lumen (Larson and Biller 2009). The presence or absence of intestinal obstruction was assessed based on visualisation of an obstructive segment with dilation of intestinal loops and abnormal motility (Sharma *et al.* 2011).

Regional lymph nodes were considered sonographically abnormal if they were hypoechoic and exhibited an increased short:long axis ratio (>0·47) resulting in a rounded appearance (De Swarte *et al.* 2011).

Abnormalities in other organs which were identified sonographically were recorded. Where cytology of these organs was performed, results were reviewed by the primary author.

RESULTS

Fifteen dogs met the inclusion criteria. A variety of breeds were represented including two Australian cattle dogs, and one of each of the following: Border collie, golden retriever, Labrador retriever, boxer, Dalmatian, German shorthaired pointer, corgi, Tibetan terrier, West Highland white terrier, Boston terrier, Jack Russell terrier, beagle and mixed breed. The median age was eight years (range 2·5-12 years) with one third of the dogs being less than 4·5 years of age and two thirds being greater than 7·5 years. The median bodyweight was 19 kg (range 4-37 kg). There were five spayed females, four neutered males and six entire males.

Five dogs presented with gastric lymphoma. One of these patients had concurrent involvement of the small intestine. Seven dogs presented with small intestinal lymphoma alone. Two dogs had lymphoma in the large intestine alone (one colon, one rectum). One dog had both small and large intestinal lymphoma.

Lesion distribution and method of diagnosis is presented in Table 1. The diagnosis of lymphoma was made by ultrasound guided fine needle aspirates obtained from eight lesions, endoscopic biopsy of one lesion and full thickness (surgical) biopsy of eight lesions. Immunohistochemistry was performed on six samples: there were three B-cell and three T-cell variants.

Clinical signs were assessed (Table 2), and were variable for each region of the GIT affected. Of the five patients with gastric lymphoma, one dog had diffuse gastric wall changes and presented for acute vomiting. Two of the five dogs presented with severe, focal sonographic changes of the gastric wall; in both cases these dogs were inappetant with weight loss, however, only one had vomiting. Two of five dogs with gastric lymphoma did not have vomiting. Inappetance, weight loss, diarrhoea and anaemia were present but inconsistent clinical signs in patients with gastric lymphoma.

All patients with small intestinal disease presented with clinical signs or findings on clinical examination which were referable to the gastrointestinal tract (Table 2), however, again clinical signs were variable. Inappetance was the presenting complaint in five dogs, three patients presented with vomiting, two with diarrhoea, two with melaena, one with weight loss and one with pyrexia. Two dogs had a palpable abdominal mass. Only one patient presented with abdominal pain. The solitary patient with lesions involving the small and large intestine presented with inappetance and lethargy. One dog had nodules within the spleen and liver detected on ultrasound examination that were suggestive of multicentric lymphoma, but diagnosis was not confirmed. Obstruction of the small intestine was not identified in any patient.

The patient with a rectal mass presented with haematechezia and tenesmus. The other patient with lymphoma isolated to the large intestine presented with pain, pale mucous membranes, vomiting, diarrhoea and pyrexia.

The sonographic characteristics of lymphoma in each region are presented in Table 3. In dogs in which the sonographic appearance of the GIT was normal, lymphoma was identified by biopsy.

Of the five dogs with gastric lymphoma, two had no sonographic abnormalities of the stomach; in these dogs a histopathological diagnosis was obtained from biopsy specimens obtained at exploratory laparotomy, in both cases the gastric wall had a normal gross appearance. In one dog the affected portion of the stomach was firm and non-compliant on palpation at surgery, prompting biopsy in this specific location; this dog had multiple

Table 1. Distribution of lymphoma within the canine gastrointestinal tract and method of biopsy

	Stomach (n=5)	Small intestine (n=9)*	Large intestine (n=3)
Cytology	2	4	2
Endoscopic biopsy		1 (T-cell)	
Full thickness biopsy	3 (1 T-cell, 2 B-cell)	4 (1 T-cell, 3 no IHC)	1 (B-cell)

n number of dogs, IHC immunohistochemistry
*Two dogs had additional regions involved, one stomach and one colon

Table 2. Clinical signs of dogs diagnosed with gastrointestinal lymphoma, according to location within the intestinal tract

	Vomiting	Weight loss	Diarrhoea	Inappetance	Anaemia	Pyrexia	Melaena
Stomach (n=5)	3/5	2/5	0/5	2/5	1/5	0/5	0/5
Small intestine (n=9)*	3/9	1/9	2/9	5/9	0/9	1/9	2/9
Large intestine (n=3)	1/3	0/3	1/3	0/3	0/3	1/3	0/3

n number of dogs
*Two dogs had additional regions involved, one stomach and one colon

Table 3. Sonographic characteristics of lymphoma according to location

Feature		Stomach (n=5)	Small intestine (n=9)*	Large intestine (n=3)
Distribution	Normal	2	2	0
	Focal	2	5	2
	Multifocal	0	1	1
	Diffuse	1	1	0
Regional lymph nodes	Normal	4	1	1
	Abnormal	1	8	2
Wall thickness	Normal	2	3	0
	Mild	1	0	0
	Moderate	1	4	1
	Severe	1	2	2
Wall layering	Normal	2	2	0
	Present but abnormal	0	1	0
	Effaced	3	6	3
Echogenicity	Normal	2	2	0
	Hypoechoic	2	5	3
	Hyperechoic	0	1	0
	Complex	1	1	0

n number of dogs
*Two dogs had additional regions involved, one stomach and one colon

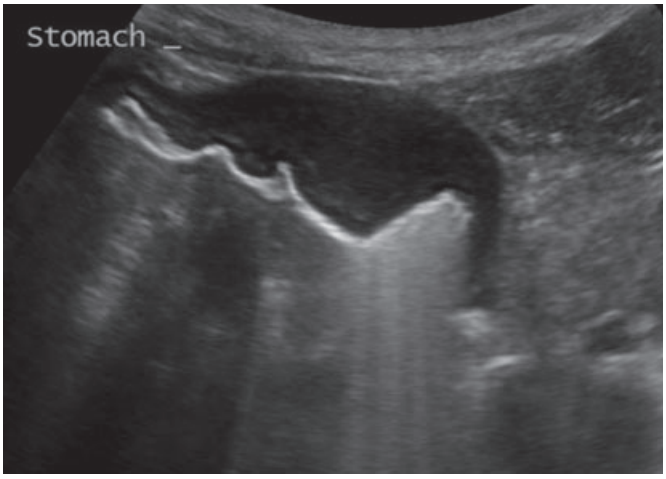

FIG 1. Moderate hypoechoic thickening of the gastric wall; 11-year-old Beagle

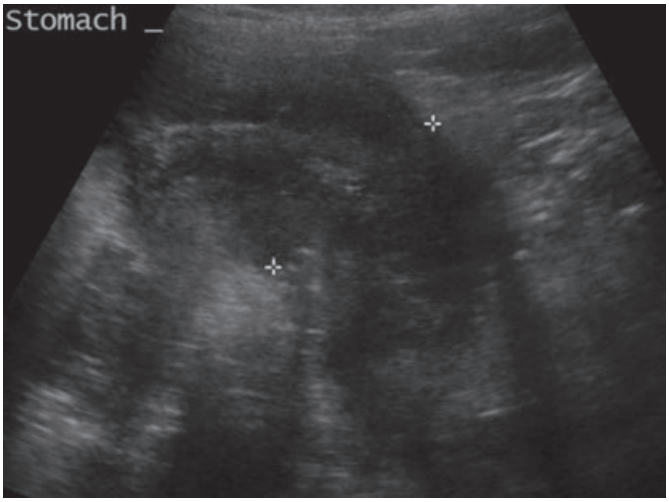

FIG 2. Severe gastric wall thickening with a complex echotexture, wall thickness is shown between the callipers (24·4 mm); nine-year-old Labrador retriever

hepatic mass lesions (also lymphoma) within one liver lobe, which had ruptured resulting in haemoabdomen. On ultrasound, the hepatic lesions ranged from small, hypoechoic nodules (1 cm) to a larger mass which measured approximately 3 cm in diameter which had a complex, cavitary appearance. The second dog had concurrent diabetes mellitus, the liver was hyperechoic on ultrasound and the histopathological diagnosis was consistent with an endocrine hepatopathy. The spleen of this dog was normal on ultrasound, however, lymphoma was diagnosed on histopathology. A third patient had diffuse mild thickening of the gastric wall with a rigid appearance, loss of wall layering and a homogenous hypoechoic echotexture. In the remaining two patients, a large mass was identified, with moderate hypoechoic thickening in one patient (Fig 1) and severe wall thickening with a complex echogenicity in the remaining dog (Fig 2). Complete loss of layering and an irregular mucosal surface was present in both of these patients, one dog had sonographic evidence of severe multifocal mucosal ulceration. Only one dog with gastric lymphoma had ultrasound evidence of abnormal regional lymph nodes. This dog had a large complex mass and multiple lymph nodes which were moderately enlarged, rounded and hypoechoic (gastric, jejunal, hepatic, ileocolic lymphocentres), (Fig 3). Gastric outflow tract obstruction was not present in any dog.

Nine patients with small intestinal lymphoma were identified. A variety of sonographic patterns were identified, including two patients in which no sonographic abnormalities were present in either the gastrointestinal tract or any other abdominal organ (Figs 4 and 5). Five dogs had focal lesions, one had multifocal lesions and one had diffuse change. Severe wall thickening was present in two dogs (Fig 6), moderate thickening in four dogs and the wall was of normal thickness in three dogs. Intestinal wall layering was commonly effaced (six dogs) (Fig 6), and was present but altered in one dog (Figs 7 and 8). Five lesions were

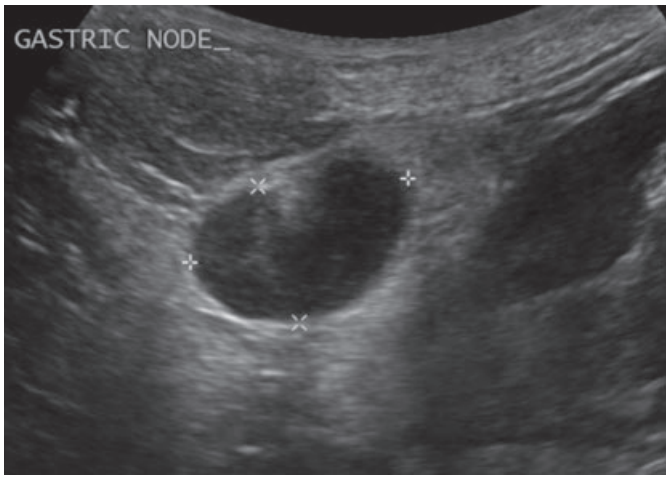

FIG 3. Abnormal gastric lymph node, the node is rounded in shape and hypoechoic with distal acoustic enhancement, note the abnormal gastric wall is visible to the right, the dimensions of the node are shown between the callipers (25·6 mm×15·6 mm); 11-year-old Beagle (also shown in Fig 1)

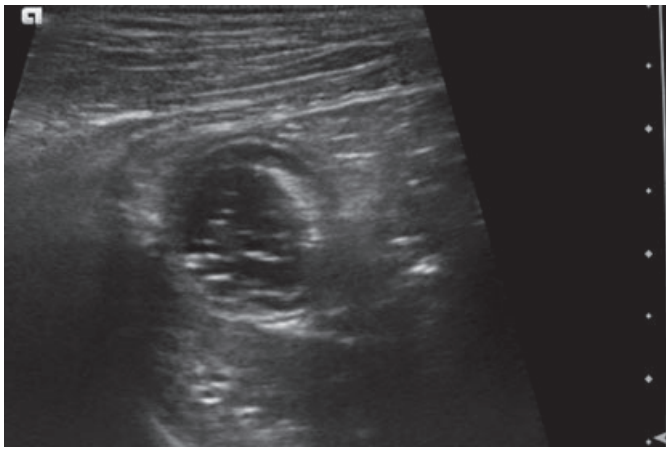

FIG 4. Transverse plane image through the duodenum of a dog with small intestinal lymphoma illustrating normal small intestinal wall thickness and layering; 4·5-year-old Jack Russell Terrier. Ileus is present

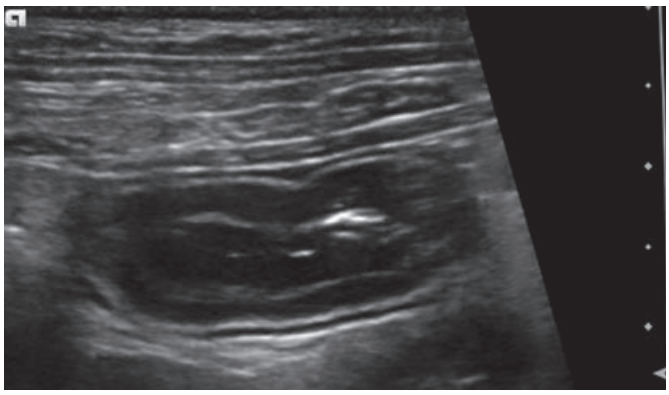

FIG 5. Longitudinal plane image through the duodenum of the same dog illustrated in Fig 4

categorised as being predominantly hypoechoic (Fig 6) and one each were hyperechoic and complex. Eight of nine dogs with small intestinal lymphoma had abnormal regional lymph nodes

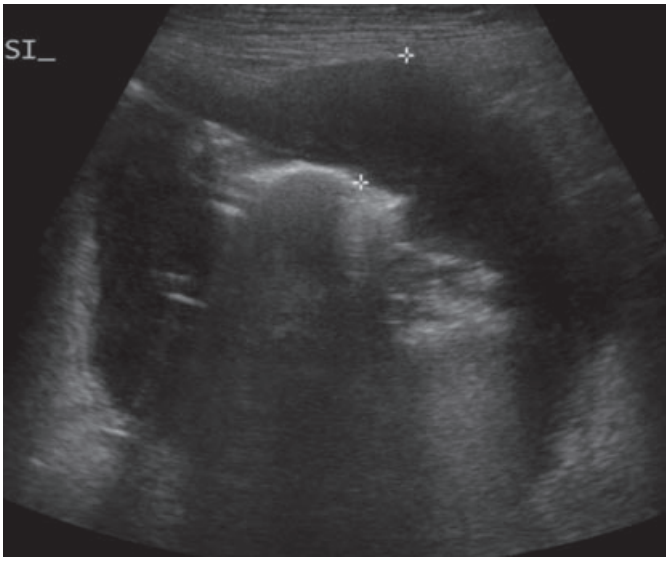

FIG 6. Long axis image of moderate small intestinal wall thickening, wall thickness shown between the callipers (15 mm); 12-year-old Australian Cattle Dog

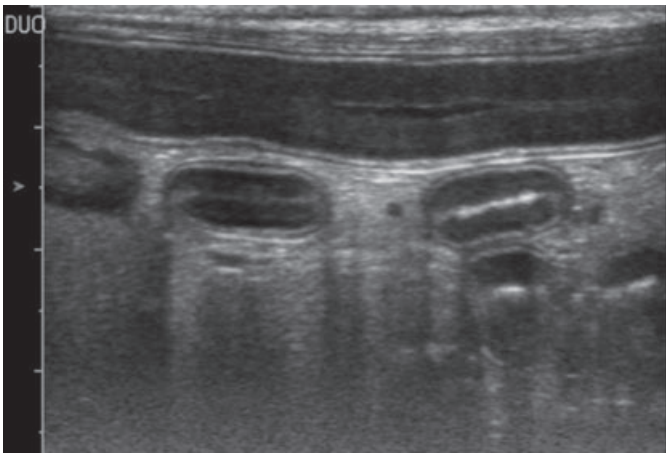

FIG 7. Transverse and longitudinal plane images through three segments of small intestine illustrating normal intestinal wall thickness with patchy hyperechoic regions throughout the mucosal layer; 11-year-old Tibetan Terrier

detected by ultrasound, including two patients with sonographically normal small intestine.

Three dogs had large intestinal lesions; two dogs had focal lesions which involved severe thickening of the bowel. These were a rectal mass (Fig 9), and a circumferential lesion of the colon (Fig 10). A third dog had multifocal, moderately thickened segments within the colon wall. The latter dog had concurrent small intestinal involvement with similar sonographic changes present in both regions (moderate wall thickening). All lesions were predominantly hypoechoic, with effacement of wall layering.

Regional lymph nodes were abnormal in both patients with focal large intestinal disease and normal in the dog with multifocal disease. One patient with focal disease of the colon had multiple splenic nodules (Fig 11). Cytology of these nodules was

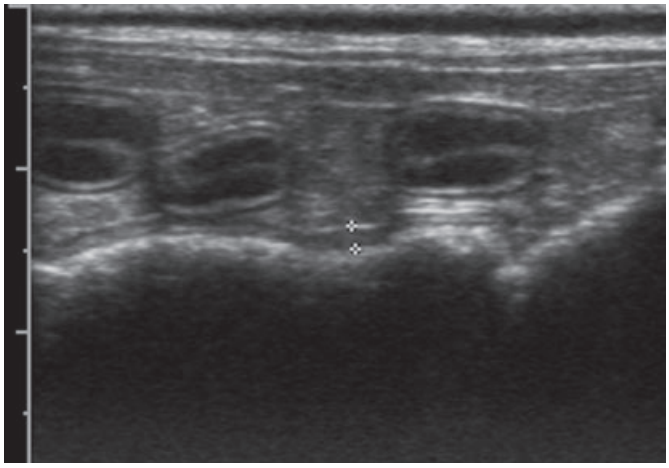

FIG 8. Transverse plane images through the small intestine and longitudinal plane image through the colon wall of the same dog illustrated in Fig 7

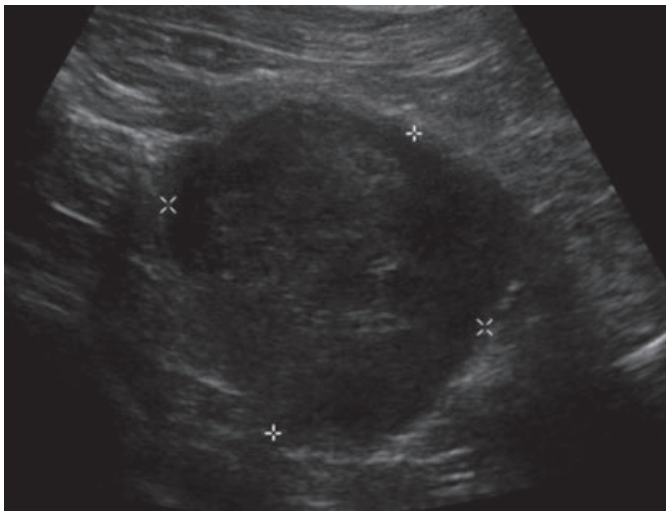

FIG 9. Short axis section through the rectal wall showing a rounded hypoechoic mass. Dimensions of the mass are shown between the callipers (38·8 mm×39·7 mm); 3-year-old Dalmatian

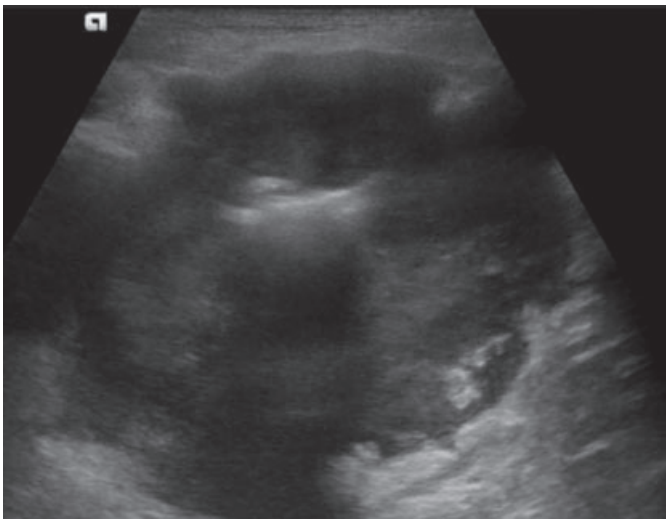

FIG 10. Circumferential hypoechoic thickening of the colon wall; 2·5-year-old West Highland White Terrier

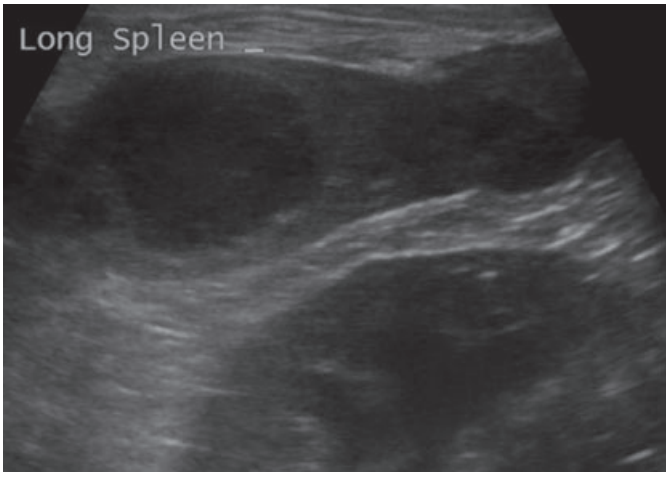

FIG 11. Well-defined rounded hypoechoic splenic nodules, the kidney is visible in the periphery; 2·5-year-old West Highland White Terrier (also shown in Fig 10)

consistent with lymphoma. Similar nodules were noted deforming the cortex of both kidneys but were not aspirated. No other metastases were noted.

DISCUSSION

Intestinal tumours account for approximately 6% of all feline tumours, 74% of which are lymphoma. Approximately 22% of all canine neoplasms are intestinal, approximately one of three of which are lymphoma. Gastric neoplasia is less common in dogs, and is estimated to be present in approximately 1% of dogs with neoplasia, the percentage of these dogs with lymphoma is poorly described (Withrow *et al.* 2007).

This study presents the sonographic findings in a series of dogs with confirmed alimentary lymphoma. In cats with intestinal lymphoma there are no reported pathognomonic sonographic findings and presenting clinical signs vary widely (Withrow *et al.* 2007, Zwingenberger *et al.* 2010). The present results indicate that these findings also hold true for dogs.

All dogs in this study but one were pure-breds, with numerous breeds of various sizes represented. Dogs fell within a large range of ages, but the median age of eight years is consistent with the reported signalment of dogs presenting with gastrointestinal lymphoma (Withrow *et al.* 2007, Rassnick *et al.* 2009). The boxer is reported to be overrepresented for intestinal lymphoma, a finding not confirmed in this study. Seventy-five percentage of the patients were male, consistent with the greater reported frequency of alimentary lymphoma in this sex (Couto *et al.* 1989).

The findings of this study indicate that clinical signs pertaining to the gastrointestinal tract are an unreliable marker of gastrointestinal lymphoma. Vomiting was present in only 40% of the cases including one with focal colonic disease. This dog did

not have biopsies of other intestinal regions and therefore the presence of lymphoma cannot be specifically ruled out in these tissues. Inappetance was similar in frequency to vomiting, also being present in 40% of dogs. Weight loss was a less common feature as was diarrhoea and intestinal obstruction was not present in any of the cases. These findings confirm that gastrointestinal neoplasms may exhibit subtle or no clinical signs until disease is advanced (Myers & Pennink 1994, Paolini *et al.* 2002).

In this study, a wide variety of sonographic features of gastrointestinal lymphoma in dogs was identified. It has been reported that in patients with sonographic abnormalities of the bowel, abnormal wall layering with concurrent increased wall thickness (>1 cm) is strongly suggestive of neoplasia (Penninck *et al.* 2003). The present results demonstrate that intestinal lymphoma may be present in bowel with normal or minimal alteration in wall thickness and layering, suggesting that distortion of wall layering is poorly sensitive for the diagnosis of lymphoma in dogs. Whilst wall layers were altered or effaced in the majority of the patients in this series, just over 20% retained normal wall layering. Wall thickness was also highly variable in dogs with intestinal lymphoma, with approximately equal numbers in the normal to mild, moderate and severe categories. In general, where sonographic abnormalities existed lesions were predominantly hypoechoic.

In four patients with histopathologically confirmed lymphoma, no sonographic abnormalities of the gastrointestinal tract were present. Two of these were gastric lesions. The normal sonographic appearance of the gastric wall in these patients varies from published descriptions of gastric lymphoma in which lesions were described as commonly sessile, hypoechoic, with moderate wall thickening and a loss of wall layering (Lamb *et al.* 1999). The numbers of dogs in the present study was small. Despite this, the results suggest that patients with gastric lymphoma may have a normal sonogram, making biopsy a more accurate method of excluding lymphoma as a differential diagnosis. Regional lymphadenopathy was not present in these patients.

Primary differential diagnoses for gastrointestinal lymphoma in dogs include adenocarcinoma, smooth muscle tumours and enteritis. Sonographic features of intestinal adenocarcinoma have been described as focal and commonly (up to 81% of cases) causing intestinal obstruction (Paolini *et al.* 2002). These features differ from the current findings where less than 50% of intestinal lesions were focal and no patients had intestinal obstruction. Despite the small sample size of this study, lack of obstruction in the face of other sonographic features of malignancy may point towards a diagnosis of intestinal lymphoma. Confirmation by aspiration or biopsy should be obtained. Smooth muscle tumours are rare and are typically reported to be large eccentric masses projecting from the bowel wall with poorly defined wall layering, heterogenous echotexture, and often with secondary abdominal effusion present (Myers & Pennink 1994). The cases of this study more commonly exhibited an anechoic to hypoechoic pattern. Abnormal wall layering was a less consistent feature. A single dog in the study had a haemorrhagic peritoneal effusion secondary to hepatic rupture (also caused by lymphoma), otherwise peritoneal effusion was not a characteristic of dogs with intestinal lymphoma.

Enteritis has been shown to differ sonographically from neoplasia including lymphoma, (Penninck *et al.* 2003), and has been described as typically being diffuse, with no or minimal alteration to wall layering or thickness. A difference in lymph node size has been identified in dogs with gastrointestinal neoplasia and enteritis, however, considerable overlap occurs between these groups (Penninck *et al.* 2003). Regional lymphadenopathy was present in over 60% of all cases in this study, with a higher proportion (90%) of dogs with small intestinal lymphoma presenting with abnormal regional lymph nodes. The presence of lymphadenopathy in conjunction with sonographically normal small intestine should raise concern for the presence of intestinal lymphoma, and prompt further investigation. In the other regions, low case numbers hamper the ability to draw accurate conclusions regarding the significance of lymphadenopathy. Cytological or histopathological confirmation of lymphoma within abnormal nodes was not available in all cases therefore the validity of the assumption of malignancy cannot be confirmed.

This study has a number of limitations, including its retrospective nature, small sample size and lack of histopathological confirmation of the diagnosis in all patients. Visualisation of the gastric lymph nodes is more difficult than other intestinal lymphocentres due to their location and gastric luminal gas, therefore false negative findings may have occurred. In both of the two patients in this study with normal sonograms in which a gastric lesion was diagnosed on histopathology, the region biopsied was well-visualised on ultrasound and therefore it is asserted that lymphoma cannot be excluded if the gastric wall has a normal appearance. It remains a possibility, however, that ultrasound assessment of the gastric wall may be impeded by the presence of luminal gas and wall plication, with the potential for false negative results in other cases. It is possible that patients with lymphoma and sonographically normal small intestine were omitted from inclusion because of absence of biopsy and histopathology. Patients with mild or diffuse intestinal changes in which the diagnosis of lymphoma was made solely on aspiration of abnormal regional lymph nodes were also excluded. Regardless, the fact that a number of dogs with confirmed lymphoma in the stomach and small intestine had a normal sonographic appearance of the GIT confirms that abdominal ultrasound may be poorly sensitive for the detection of this disease.

The use of ultrasound for the diagnosis of gastrointestinal neoplasia in dogs is widespread; however, the specific sonographic features of gastrointestinal lymphoma have not been well-described in isolation in this species. This study reveals that the sonographic appearance of gastrointestinal lymphoma in dogs is highly variable and overlaps with that of normal bowel, other neoplastic conditions and enteritis. Presenting clinical signs may also be variable. Whilst gastrointestinal lymphoma in dogs may not be as common as other intestinal neoplasia or inflammatory disease, it should be maintained as a differential diagnosis, despite the presence of sonographically normal appearing bowel.

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Conflict of interest

None of the authors of this article has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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