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How useful is abdominal ultrasonography in dogs with diarrhoea?

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Running head: Ultrasonography in dogs with diarrhoea

Structured summary

Objective. To assess the utility of abdominal ultrasonography (AUS) in the diagnostic work-up of dogs with diarrhoea.

Methods. A retrospective, cross-sectional study based on a referral population of dogs with diarrhoea was done to test the associations between the clinical signs, use of AUS, results of AUS and subsequent work-up. The utility of AUS was scored as high, moderate, none or counterproductive based on review of medical records.

Results. Medical records of 269 dogs were reviewed, of which 149 (55%) dogs had AUS. The most frequent result of AUS was no ultrasonographic abnormalities affecting the intestine in 65 (44%) dogs. AUS results were associated with subsequent work-up as follows: no abnormalities on AUS and dietary trial; focal thickening of the intestinal wall, loss of intestinal wall layers and/or enlarged abdominal lymph nodes and ultrasound-guided FNA; diffuse thickening of the intestinal wall or hyperechoic striations in the small intestinal mucosa and endoscopy; and small intestinal foreign body and coeliotomy. AUS had high utility in only 4 (3%) dogs – two had a portosystemic shunt identified ultrasonographically, one had a linear foreign body and one had a perforated pyloric ulcer; in each of these dogs the results of AUS were considered diagnostic without further testing. AUS had moderate utility in 56 (38%) dogs and no utility in 79 (53%) dogs. AUS was considered counterproductive in 10 (7%) dogs because results were either falsely negative or falsely positive.

Impact. These results should prompt clinicians to reconsider routine use of AUS in dogs with diarrhoea.

Introduction

Diarrhoea, an increase in volume, frequency and/or water-content of faeces, is a common reason for dogs to be presented for veterinary consultations. Many causes of diarrhoea have been recognised, including dietary indiscretion, parasitism, viral or bacterial infections, inflammatory bowel disease (IBD), lymphangiectasia, gastrointestinal neoplasia and metabolic disorders (Allenspach, 2013). Although many dogs with acute diarrhoea are managed satisfactorily with empirical treatment, diagnostic work-up is indicated, particularly in dogs with recurrent or chronic diarrhoea. A wide range of tests are applicable to diagnosis of diarrhoea, including haematology, serum biochemical analysis, urinalysis, faecal parasitology, trypsin-like immunoreactivity (for suspected exocrine pancreatic insufficiency), canine specific pancreatic lipase (for suspected pancreatitis) (Mansfield, 2013), adrenocorticotrophic hormone stimulation test (for suspected hypoadrenocorticism) and serum folate and cobalamin concentration (to assess proximal and distal small intestinal absorption, respectively) (Allenspach, 2013). A trial period with an elimination diet or hydrolysed diet is indicated in dogs with suspected food responsive disease (Burgener et al. 2008, Allenspach, 2013, Allenspach et al., 2016). Endoscopic biopsies may be useful, particularly in differentiation of IBD from neoplasia (Allenspach, 2013).

Abdominal ultrasonography (AUS) is frequently used in the diagnostic work-up of dogs with suspected gastrointestinal disorders (Gaschen, 2011). Previous reports have described the ultrasonographic appearance of the normal canine gastrointestinal tract (Penninck et al., 1989), gastrointestinal neoplasia (Myers & Penninck 1994; Penninck et al. 2003), intestinal foreign bodies (Tidwell & Penninck, 1992), obstruction, enteritis, (Penninck et al., 1990), intussusception (Lamb & Mantis, 1998) and lymphangiectasia (Kull et al. 2001). There have been numerous ultrasonographic studies of the intestinal wall, including measurements of intestinal wall thickness (Penninck et al., 1989; Delaney et al. 2003; Gaschen, 2011; Gladwin et al., 2014; Guenther et al., 2014). Increased thickness of the intestinal wall (Lecoindre et al. 2010) and altered echogenicity of wall layers (Kull et al. 2001; Penninck et al. 2003; Sutherland-Smith et al. 2007; Gaschen et al., 2008; Lecoindre et al.

2010; Bota et al. 2016) have been reported in some dogs with diarrhoea; however, Rudorf et al (2005) found no association between ultrasonographic intestinal wall thickness and either the histological diagnosis or the response to treatment in dogs with diarrhoea. Gaschen et al (2008) suggested that mucosal echogenicity may be a more accurate indicator of IBD than intestinal wall thickness in dogs with chronic diarrhoea.

On the basis of these observations, AUS is frequently used in the diagnostic work-up of dogs with diarrhoea, particularly those with chronc signs; however, there is a lack of information about the usefulness of this procedure in clinical practice. In this context, a highly useful diagnostic test would be sufficiently accurate to make other testing unnecessary and a moderately useful test, if not diagnostic, would provide information that optimised selection of further tests. A prospective study of the diagnostic utility of AUS in 87 dogs with chronic diarrhoea (at least three weeks duration) found that abnormalities were most likely to be detected ultrasonographically in dogs with weight loss and/or a palpable abdominal or rectal mass (Leib et al., 2012). AUS was classified as vital or beneficial to the diagnosis in 15% dogs, but in 66% dogs, the same outcome would have occurred had AUS not been performed (Leib et al., 2012). This study contributed significantly to the debate about how best to work-up dogs with diarrhoea, but potentially exaggerated the utility of AUS because cytological diagnosis achieved following ultrasound-guided fine needle aspirates was classified as an ultrasonographic diagnosis (Leib et al., 2012). Another limitation was that the ultrasonographic findings were not described.

The aims of the present study was to assess the usefulness of AUS in a referral population of dogs with diarrhoea by testing the associations between the clinical signs, use of AUS, results of AUS and subsequent work-up, and by assigning a utility score based on review of medical records.

Materials and Methods

Medical records of patients first seen at in the 12-month period, from

December 2014 to November 2015, were searched for dogs whose presenting signs included the terms *diarrhoea, haematochezia* or *melena*. Search included dogs examined by the first-opinion service and dogs referred for investigation of diarrhoea. Dogs were excluded if diarrhoea was not the primary presenting sign, for example if a dog with neoplasia developed diarrhoea during a course of chemotherapy.

Medical records were reviewed by one author ( ) and the following data extracted:

- Patient details – age; gender; breed; body weight (kg); body condition score (/9)
- Reported clinical signs – reported duration of diarrhoea; other clinical signs (vomiting; weight loss; reduced appetite or lethargy)
- Physical examination findings – signs of abdominal pain; palpable abdominal mass; signs of hypovolaemia; pyrexia (rectal temperature >39.3C)
- Type of diarrhoea – small intestinal; large intestinal or mixed, as determined by the attending clinician using published guidelines (Allenspach, 2013)
- Results of serum biochemistry – hypoproteinaemia (total protein <49g/L); hypoalbuminaemia (albumin <28g/L) hypoglobulinaemia (globulin <14.8g/L); high canine specific pancreatic lipase (>201µg/L)
- Use of other diagnostic tests – abdominal radiography; computed tomography (CT); magnetic resonance imaging (MRI); abdominal ultrasound (AUS); ultrasound-guided fine needle aspirates (FNA); upper gastrointestinal endoscopy and biopsy; colonoscopy and biopsy; coeliotomy and biopsy; dietary trial
- Diagnosis as determined by the attending clinician – gastroenteritis of unknown aetiology; inflammatory bowel disease (IBD); protein-losing enteropathy (PLE); dietary indiscretion; lymphoma; other neoplasia; parasitism; secondary to non-gastrointestinal disease (e.g. chronic renal disease); undetermined.

Cases were managed by small animal internal medicine or surgery residents under the supervision of board certified specialists. Ultrasound scans were done by 4 board-certified radiologists or imaging residents under their direct observation.

Results of AUS, as recorded in contemporaneous reports, were extracted by a board-certified veterinary radiologist ( ). The AUS results, results of subsequent tests and the clinical diagnosis in each case were reviewed jointly by two investigators ( ) reaching a consensus by discussion, and the utility of AUS was scored as 1 high, 2 moderate, 3 none or 4 counterproductive as follows :

Score 1: High utility – AUS alone was diagnostic; no further diagnostic testing was necessary.

Score 2: Moderate utility – AUS revealed lesions that could reflect the cause of diarrhoea (e.g. thickening of the intestinal wall, abnormal pancreas); additional diagnostic testing was necessary for diagnosis.

Score 3: No utility – AUS was normal and cause of diarrhoea was subsequently shown to be unassociated with morphologic lesions; or if abnormalities were found by AUS, the findings were non-specific signs of diarrhoea (e.g. increased volume of fluid in the intestine); or abnormalities found by AUS were considered unrelated to diarrhoea (e.g. urinary calculi)

Score 4: Counterproductive – AUS was potentially misleading because it was falsely negative (cause of diarrhoea was subsequently shown to be associated with morphologic lesions found by other tests); or positive for lesions subsequently proven to be unrelated to diarrhoea, but requiring additional work-up; or falsely positive.

Clinical data were summarised using median (range). Associations between the clinical signs, use of AUS, results of AUS and subsequent work-up were tested by one investigator ( ) using commercially available software (SPSS, Version 22, IBM Corp, Armony, NY). Associations between

the likelihood of having an ultrasound performed and patient age, clinical signs, results of serum biochemistry and type of diarrhoea were tested using binary logistic regression. Associations between having an ultrasound scan performed and use of further diagnostic tests were also tested using binary logistic regression. Associations between utility score and patient age, clinical signs, results of serum biochemistry and type of diarrhoea were also tested using logistic regression. Results of regression analyses were expressed as odds ratio (OR) and 95% confidence interval (CI). Results with $p<0.05$ were considered statistically significant.

Results

The initial medical record search identified 505 visits for dogs that had diarrhoea as a presenting sign. Of these, 236 were excluded because they were repeat visits (i.e. the dog first presented before the inclusion dates) or because diarrhoea was not the main complaint, leaving 269 dogs that met the inclusion criteria for this study. There were 159 (59%) females (124 spayed and 35 intact) and 110 (41%) males (59 entire and 51 intact). Breeds are summarised in table 1. The most common breeds were mixed breed dogs (19%) and Labrador retrievers (6%). Median age of these dogs was 5.6 years (range 1month – 18 years). Median body weight was 14.2kg (range 0.5–65.6kg). On the basis of a body condition score (BCS) in 115 dogs in which it was recorded, 68 (59%) were considered underweight (BCS<5) and 15 (13%) were overweight (BCS>5). The median duration of diarrhoea prior to presentation was 5 days (range 1 day – 6 years). 159 (59%) of dogs had diarrhoea for ≤ 21 days. 39 (15%) of dogs had diarrhoea for > 21 days. In 71 (26%) cases, the duration of diarrhoea was not recorded.

The clinical signs, physical examination findings and results of serum biochemical analysis are summarised in table 2. The most prevalent clinical sign, in addition to diarrhoea, was vomiting, which was reported in 183 (68%) dogs (including 16 with haematemesis). On the basis of their clinical signs, 110 (41%) dogs were classified as having small intestinal diarrhoea, 67 (25%) had large

intestinal and 47 (17%) had mixed-bowel diarrhoea.

Dogs that had AUS were significantly more likely to have signs of abdominal pain (OR 2.2, 95% CI 1.2-3.9), melena (OR 3.0, 95% CI 1.1-8.1) and hypoalbuminaemia (OR 5.3, 95% CI 2.3-12.0) than dogs that did not have AUS.

Further diagnostic testing included AUS in 149 (55%) dogs, abdominal radiography in 15 (6%), CT in 23 (9%), ultrasound-guided fine needle aspirates (FNA) in 18 (7%), upper gastrointestinal endoscopy and biopsy in 35 (13%), colonoscopy and biopsy in 27 (10%), coeliotomy and biopsy in 11 (4%), dietary trial in 29 (11%) and bone marrow cytology in 2 (<1%) dogs. AUS had been performed by one of four radiology residents under the supervision of one of six board certified radiologists.

Dogs that had AUS were significantly more likely to have other diagnostic tests including ultrasound-guided FNA (OR 5.9, 95%CI 1.6-22.3), dietary trial (OR 9.0, 95%CI 2.8-29.1), upper gastrointestinal endoscopy (OR 45.3, 95%CI 5.8-351.0) and coeliotomy (OR 8.4, 95%CI 1.6-45.4) than dogs that did not have AUS.

Of 149 dogs that had AUS, no ultrasonographic abnormalities were detected affecting the intestine in 65 (44%) dogs, intestinal dilatation was reported in 21 (14%), reduced small intestinal motility in 12 (8%), focal intestinal wall thickening in 18 (12%), diffuse intestinal wall thickening in 10 (7%), loss of intestinal wall layers in 11 (7%), hyperechoic striations in the mucosal layer of the small intestine in 9 (6%), intestinal mass in 4 (3%) and small intestinal foreign body in 4 (3%). Non-intestinal findings were peritoneal fluid in 30 (20%) dogs, enlarged abdominal lymph nodes in 29 (19%), pancreatic abnormalities in 25 (17%), hepatomegaly and/or splenomegaly in 21 (14%), nodule or mass affecting the liver or spleen in 19 (13%), urinary calculi in 12 (8%), prostatomegaly in 5 (3%), congenital portosystemic shunt in 2 (1%) and adrenal mass in 2 (1%) dogs. In 41 (28%) dogs no ultrasonographic abnormalities were identified in the abdomen. The associations between ultrasound findings pertaining to the gastrointestinal tract and use of further diagnostic tests (n>5) are summarised in table 3. The following associations were found to be statistically significant: no abnormalities on AUS

and dietary trial (p=0.02); focal thickening of the intestinal wall and ultrasound-guided FNA (p=0.02); diffuse thickening of the intestinal wall and colonoscopy (p=0.02); loss of intestinal wall layers and ultrasound-guided FNA (p<0.001); hyperechoic striations in the small intestinal mucosa and upper gastrointestinal endoscopy, colonoscopy and both (p=0.01); small intestinal foreign body and coeliotomy (p=0.02); enlarged abdominal lymph nodes and ultrasound-guided FNA (p<0.001).

Clinical diagnoses were recorded as follows: gastroenteritis with unknown aetiology in 102 (38%) dogs, IBD in 44 (16%), PLE in 25 (9%) dietary indiscretion in 18 (7%), pancreatitis in 16 (6%), lymphoma in 11 (4%), other neoplasia in 9 (3%), chronic renal disease in 6 (2%), colitis or typhlitis in 6 (2%), immune-mediated disease in 5 (2%), parasitism in 3 (1%) and portosystemic shunt in 3 (1%). There were single instances of other specific diagnoses in 8 (3%) dogs. In the remaining 13 dogs (9%) a final diagnosis was not recorded.

Dogs that had AUS were significantly more likely to have a diagnosis of IBD (OR 6.4, 95% CI 2.1-19.3) or pancreatitis (OR 4.9, 95% CI 1.1-23.2) and significantly less likely to have a diagnosis of gastroenteritis (OR 0.3, 95% CI 0.09-0.5) than dogs that did not have AUS.

Of 11 dogs that had intestinal lymphoma, 7 had AUS and, of these, 3 (43%) had no abnormalities, 2 (29%) had diffuse intestinal wall thickening with loss of layers and enlarged abdominal lymph nodes, 1 (14%) had focal intestinal wall thickening and enlarged abdominal lymph nodes, and 1 (14%) had hepatic and splenic nodules, enlarged abdominal lymph nodes and peritoneal fluid.

The utility score assigned to AUS was 1 (diagnostic) in 4 (3%) dogs. Two of these had a portosystemic shunt identified ultrasonographically, one dog had a linear foreign body and one dog had a perforated pyloric ulcer; in each of these dogs the results of AUS were considered diagnostic. The utility score was 2 in 56 (37%) dogs, 3 in 79 (53%) dogs and 4 in 10 (7%) dogs. Of the 10 dogs with utility score 4 (counterproductive), 3 had an abdominal mass that required further work-up but was unrelated to the cause of diarrhoea, 3 had no abnormalities on AUS but diagnosis of intestinal lymphoma on subsequent endoscopic biopsies, 2 had pancreatic abnormalities reported on AUS but

206 no other clinical or pathological findings to suggest pancreatic disease, and 2 were reported as
207 having diffuse intestinal wall thickening and enlarged abdominal lymph nodes on AUS but
208 subsequent testing supported diagnosis of food-responsive diarrhoea and hepatic toxicity,
209 respectively. No significant associations were found between utility score and patient age, clinical
210 signs, results of serum biochemistry and type of diarrhoea.

211

212 **Discussion**

213 AUS was performed in just over half of the dogs presented to our hospital primarily for diagnostic
214 work-up of diarrhoea in a 12-month period. Multiple additional clinical signs were reported in many
215 instances, hence the indication for AUS was based on more than just diarrhoea. Dogs with
216 abdominal pain, melena or hypoalbuminaemia were more likely to have AUS included in their work-
217 up than dogs lacking these signs. These results likely represent decisions by clinicians that AUS is
218 indicated to look for signs of pancreatitis, a bleeding ulcer or neoplasia, or reasons for protein-losing
219 enteropathy, respectively. Other patient variables, including age, duration of signs and occurrence of
220 vomiting or weight loss, were not significantly associated with use of AUS.

221 Dogs that had AUS were significantly more likely to have multiple other diagnostic tests, including
222 ultrasound-guided FNA, dietary trial, upper gastrointestinal endoscopy and coeliotomy than dogs
223 that did not have AUS. This result is compatible with the observation that in dogs with diarrhoea AUS
224 usually finds either no abnormalities or non-specific abnormalities requiring further investigation. In
225 referral practices, AUS is routinely used in the diagnostic work-up of dogs with chronic diarrhoea not
226 because it is liable to be diagnostic, but because it may help determine if the small or large intestine
227 is the affected and if there are mass lesions requiring surgical treatment (Allenspach, 2013).
228 Diagnosis of gastroenteritis was more frequent in dogs that did not have AUS. This finding likely
229 reflects the fact that this is a non-specific diagnosis, most likely to be applied to dogs with more
230 acute and/or self-limiting clinical signs for which a diagnostic work-up was considered unnecessary.

231 Associations were found in the present study between finding focal thickening of the intestinal wall
232 and ultrasound-guided FNA, and between finding a small intestinal foreign body by AUS and
233 subsequent coeliotomy, which support this approach; however, finding hyperechoic striations in the
234 small intestinal mucosa was associated with subsequent upper gastrointestinal endoscopy,
235 colonoscopy and both. Based on reivew of medical records, it is not clear that the site of abnormality
236 found on AUS was used to guide the endoscopy; however, in dogs with suspected small intestinal
237 lesion, colonoscopy is often performed for the purpose of ileoscopy, not to examine the colon per
238 se. Hence, upper and lower gastrointestinal endoscopy may be employed regardless of ultrasound
239 findings. Gaschen et al (2008) suggested that increased mucosal echogenicity may be a more
240 accurate indicator of IBD than intestinal wall thickness in dogs with chronic diarrhoea; however, a
241 more recent study found that up to 50% normal dogs had hyperechoic foci in the intestinal mucosa if
242 scanned within 1 hour of a meal (Gaschen et al. 2016). Hence the value of using this finding to help
243 select further diagnostic tests is doubtful because it may not represent a pathological change.

244 One potential benefit of abdominal ultrasound is that it can guide clinicians into pursuing a
245 therapeutic trial rather than more invasive tests (Leib et al., 2012), but it is not known how
246 frequently this occurs. Ultrasonography is non-invasive, safe and does not require general
247 anaesthesia, but it is a relatively expensive test and dogs with diarrhoea have a relatively low
248 probability of morphological lesions to explain their disease, which means the indication for AUS is
249 weak (Weinstein et al. 2005). AUS lacked utility in half the dogs in the present series. A large
250 proportion of dogs (44%) had no ultrasonographic findings pertinent to the gastrointestinal tract and
251 many more had non-specific findings, the significance of which could only be determined by other
252 tests. Several large studies found that most dogs presenting with chronic diarrhoea are food
253 responsive (A;lenspach JVIM 2008 and Allenspach Vet Rec 2016), hence it is therefore advisable that
254 all dogs with chronic diarhoea undergo a food trial as an initial step in their diagnostic workup.

255 AUS indicated a specific cause for diarrhoea in only 3% dogs in the present series. This result may be
256 compared with that of Leib et al. (2012) who considered AUS to be vital to diagnosis in 10% dogs

257 with diarrhoea of greater than 3 weeks duration, although that figure included cases in which the
258 diagnosis was obtained by ultrasound-guided FNA or biopsy rather than by ultrasonography per se.
259 In their study of AUS in dogs with diarrhoea, Leib et al. (2012) found that increased diagnostic utility
260 of AUS was associated with palpation of an abdominal or rectal mass or weight loss, but the present
261 study did not reproduce these results. Only 3% dogs in the present study had a palpable abdominal
262 mass, compared to 7% in the study by Leib et al. (2012). No significant associations were found in
263 the present study between utility score and patient age, clinical signs, results of serum biochemistry
264 and type of diarrhoea, hence it is not possible to make specific recommendations about which dogs
265 with diarrhoea are the best candidates for AUS.

266 The importance of finding such a low frequency of ultrasonographic diagnosis is that it should
267 prompt clinicians to reconsider routine use of AUS in dogs with diarrhoea, especially in acute cases
268 without systemic signs, and in chronic cases with mild clinical severity (Allenspach et al. 2016). Utility
269 scores 2 and 3, representing dogs with non-specific or negative findings, accounted for 90% cases in
270 the present study. If the usual result in dogs with diarrhoea is a negative study or non-specific
271 findings, it does not represent a good use of resources, particularly since AUS is one of the most
272 expensive non-invasive diagnostic tests routinely available in veterinary practice. As illustrated in the
273 present study by the results in dogs with intestinal lymphoma, AUS is not sufficiently sensitive that a
274 negative study enables specific diagnoses to be ruled out. Furthermore, if our results are
275 representative, and dogs in which AUS indicated a specific cause for diarrhoea are outnumbered by
276 those in which is is counterproductive, AUS may be best avoided in the work-up of most dogs with
277 diarrhoea.

278 Limitations of this study are related to its retrospective nature. In particular, there was no standard
279 protocol that dictated the diagnostic work-up. Instead, the case management was determined by
280 the clinician with the agreement of the owner. Ultrasonography was done by specialist radiologists
281 working independently without consensus but with knowledge of the clinical history and likely

differential diagnosis at the time of ultrasonography. Under these circumstances, AUS interpretation will be subject to inter-observer variations and bias (such as confirmation bias), but such variability cannot be quantified.

A further limitation was the lack of follow-up of cases, which would have the potential advantage of increasing confidence in a proportion of the clinical diagnoses. The utility score relied partly on the diagnosis, as determined by the clinician, hence it is possible that changing the diagnoses based on findings at follow-up could alter the utility score in some of the affected dogs. However, it is difficult to envisage an increase in utility score occurring as a result of corrected diagnosis.

We included cases with an open diagnosis or without histological or cytological confirmation of the diagnosis because such cases represent a meaningful proportion of a diarrhoea caseload and because lack of a final diagnosis is partly a reflection of the lack of utility of AUS. It should be emphasised that this study does not enable estimation of the accuracy of AUS for specific diagnoses because of the inclusion of cases with open or presumptive diagnosis. Without a means to accurately classify dogs, the accuracy of AUS is unknown. Nevertheless, the lack of utility of AUS in a large proportion of dogs in this study should prompt clinicans to reconsider routine use of AUS in dogs with diarrhoea.

No conflicts of interest have been declared.

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360

Table 1. Summary of breeds

Breed	Number
Mixed breed	50 (19%)
Labrador Retriever	30 (11%)
Jack Russell Terrier	16 (6%)
Staffordshire Bull Terrier	16 (6%)
Cocker Spaniel	14 (5%)
Miniature Schnauzer	10 (4%)
German Shepherd Dog	10 (4%)
Shih-Tzu	7 (3%)
Rottweiler	6 (2%)
Golden Retriever	5 (2%)
Border Collie	4 (1%)
Rhodesian Ridgeback	4 (1%)
Cavalier King Charles Spaniel	4 (1%)
Weimeraner	3 (1%)
Border Terrier	3 (1%)
Cairn Terrier	3 (1%)
Chihuahua	3 (1%)
Cockerpoo	3 (1%)
English Springer Spaniel	3 (1%)
Greyhound	3 (1%)
Hungarian Vizsla	3 (1%)
Miniature Dachshund	3 (1%)
Shar-pei	3 (1%)
Whippet	3 (1%)
Yorkshire Terrier	3 (1%)

Table 2. Concurrent clinical signs, physical examination findings and serum chemistry results in dogs with diarrhoea

Clinical signs	Number
Vomiting	183 (68%)
Including haematemesis	16 (6%)
Lethargy	106 (39%)
Decreased appetite	88 (33%)
Weight loss	43 (16%)
Melena	30 (11%)
Polyruia/polydipsia	15 (6%)
Regurgitation	12 (4%)
Flatulence or borborygmi	7 (3%)
Physical examination findings	
Abdominal pain	72 (27%)
Hypovolaemia	32 (12%)
Pyrexia	17 (6%)
Icterus	7 (3%)
Erythematous skin	6 (2%)
Palpable abdominal mass	6 (2%)
Palpable rectal mass	2 (1%)
Serum chemistry	
Panhypoproteinaemia	37 (14%)
Raised cPLi	20 (7%)
Anaemia	13 (5%)
Hypoalbuminaemia	5 (2%)
Hypoglobulinaemia	2 (1%)

Table 3. Associations between the results of abdominal ultrasound and use of further diagnostic tests (n>5) in 149 dogs with diarrhoea

	Further diagnostic tests							
Results of ultrasound	Abdominal radiography n=15	CT n=8	Ultrasound-guided fine needle aspirates n=14	Upper gastrointestinal endoscopy and biopsy n=34	Colonoscopy and biopsy n=27	Both upper and lower gastrointestinal endoscopy n=25	Coeliotomy n=9	Dietary trial n=25
No abnormalities detected	7 (47%)	3 (38%)	2 (14%)	16 (47%)	12 (44%)	11 (44%)	1 (11%)	**18 (72%)***
Intestinal dilatation	3 (20%)	0	2 (14%)	2 (6%)	2 (7%)	2 (8%)	3 (33%)	3 (12%)
Focal intestinal wall thickening	3 (20%)	0	**5 (36%)***	2 (6%)	2 (7%)	2 (8%)	3 (3%)	1 (4%)
Diffuse intestinal wall thickening	0	1 (13%)	1 (7%)	4 (12%)	**5 (19%)***	4 (16%)	0	1 (4%)
Loss of intestinal wall layers	1 (7%)	0	**8 (57%)***	0	1 (4%)	0	2 (22%)	1 (4%)
Hyperechoic striations in small intestinal mucosa	0	0	0	**7 (21%)***	**5 (19%)***	**5 (20%)***	0	1 (4%)
Intestinal mass	0	1 (13%)	1 (7%)	0	0	0	1 (11%)	0
Small intestinal foreign body	1 (7%)	0	0	1 (3%)	0	0	**4 (22%)***	1 (4%)
Reduced small intestinal motility	3 (20%)	1 (13%)	0	1 (3%)	1 (4%)	1 (4%)	1 (11%)	1 (4%)
Peritoneal fluid	3 (20%)	1 (13%)	4 (29%)	8 (24%)	7 (26%)	6 (24%)	4 (44%)	2 (8%)
Enlarged abdominal lymph nodes	3 (20%)	0	**9 (64%)***	7 (21%)	7 (26%)	6 (24%)	2 (22%)	2 (8%)
Pancreatic abnormalities	3 (20%)	3 (38%)	2 (14%)	2 (6%)	2 (6%)	2 (8%)	2 (22%)	3 (12%)

*p<0.05