CLINICAL INSIGHTS

IMAGING ESSENTIALS

Ultrasonography of the Gastrointestinal Tract: Ileum, Cecum, Colon

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Welcome to our series of articles on small animal abdominal ultrasonography. The initial articles provided an overview of basic ultrasonography principles and a discussion about how to perform a systematic scan of the abdomen. The rest of the series discusses ultrasound evaluation of specific abdominal organs/systems. Read the other small animal abdominal ultrasonography articles published in *Today's Veterinary Practice* at tvpjournal.com.

LOCALIZATION AND SCANNING TECHNIQUE

Dogs and cats are positioned in dorsal or lateral recumbency for scanning of the gastrointestinal tract. Longitudinal axis and transverse axis views of the different segments of the gastrointestinal tract are necessary for a complete examination.

Maintain a consistent sequence when evaluating the complete gastrointestinal tract; preferably, in the following order: stomach, duodenum, jejunum (see "Ultrasonography of the Gastrointestinal Tract: Stomach, Duodenum, and Jejunum" [January/February 2018]), ileum, (cecum), ileocecocolic (cat) or ileocolic (dog) junction, cecum, and parts of the colon (ascending, transverse, descending).

Ileum

The normal canine and feline ileum is short and is typically located in the right cranial to mid-quadrant of the abdominal cavity, medial to the right kidney. The ileum can be found using the transverse colon or ileo(ceco)colic junction as a guide.

The transverse colon, which is immediately caudal to the gastric body, is followed to the right of midline to the level of the ascending colon; continuing in an oral direction, bypass the ileo(ceco)colic junction to image the ileum.

The ileum is more difficult to identify in dogs than cats due to interposition of the normal gas filled cecum.

Ileocecocolic and Ileocolic Junctions

The ileocecocolic junction (cats) or ileocolic junction (dogs) is usually located within the right cranial abdominal quadrant medial to the right kidney (**FIGURES 1 AND 2**).

Cecum

The canine and feline cecum is a blind sac that is medial to the descending duodenum and can usually be found caudolateral to the ileo(ceco)colic junction. Due to the superimposition of gas filled intestinal segments, the cecum is not always identifiable.

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Colon

All parts of the colon are fully evaluated by beginning at the level of the ileocecocolic junction in the cat and ileocolic junction in the dog and sweeping the transducer cranially along the ascending colon. The ascending colon is a short segment of large intestine in the right cranial abdominal quadrant.

Continue leftwards along the transverse colon. The transverse colon spans the right to left cranial abdomen and can readily be identified using the stomach as a landmark; it is located immediately caudal to the greater curvature of the stomach (**FIGURE 1**). Finish scanning the colon by continuing caudally along the descending colon.

Using the urinary bladder as a landmark to identify the descending colon (**FIGURE 2**), a reversed approach (descending colon, transverse colon, and then ascending colon) can also be used. The descending colon, usually containing gas or feces, is located immediately dorsal to the urinary bladder, within the far field of the image.

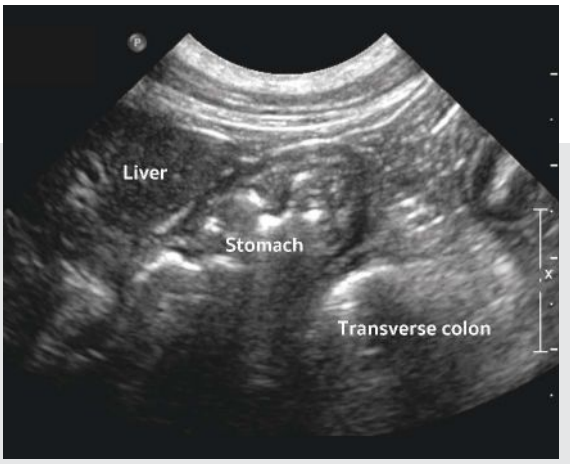

FIGURE 1. Short axis view of the transverse colon in a dog; the transverse colon is located caudal to the liver and stomach. On this sagittal image of the abdomen (cranial is to the left), note the thin walled, gas filled transverse colon with dirty acoustic shadowing.

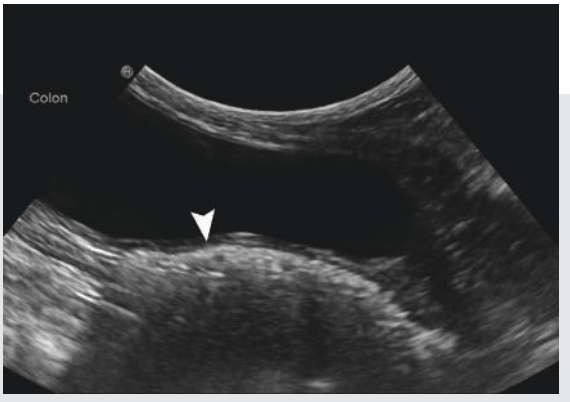

FIGURE 2. Short axis view of the caudal aspect of the descending colon in a dog. Note the thin walled (**white arrowhead**), gas filled descending colon with dirty acoustic shadowing. The urinary bladder is used as a landmark to find the descending colon in the far field of the image.

BOX 1 Criteria for assessing the ileum and colon include:

- Uniformity in diameter
- Wall thickness (**TABLE 1**)
- Discrete wall layering
- Presence of luminal contents
- Peristalsis

TABLE 1 Normal Ultrasonographic Measurements (95% Confidence Intervals) of Gastrointestinal Tract Wall Thickness in Dogs and Cats

SEGMENT OF GASTROINTESTINAL TRACT	DOG WALL THICKNESS	CAT WALL THICKNESS
Stomach	3 – 5 mm[1]	2 mm (inter-rugal)[2,3] and 4 mm (rugal fold thickness)[2]
Duodenum	Up to 5 mm[4]	2 – 2.5 mm[5,6]
Jejunum	2 – 5 mm[5]	2 – 2.5 mm[5,6]
Ileum	2 – 4 mm[5]	2.5 – 3.2 mm[2,5,6]
Colon	2 – 3 mm[5]	1.4 – 2.5 mm[5]
Cecum	1.5 mm[7]	1.5 – 2 mm[8-10]

Note: *Normal ultrasonographic measurements of the individual layers of the canine[11] and feline[6,12] gastrointestinal tract have been described in recent literature.*

NORMAL ULTRASONOGRAPHIC FEATURES OF THE GASTROINTESTINAL TRACT

Canine and feline gastrointestinal wall thicknesses vary depending on the segment assessed (**TABLE 1**).

Ileum and Cecum

The ileum of cats has prominent submucosa and muscularis layers (**FIGURE 3**) and, due to a limited accumulation of mucus and gas, commonly has an ultrasonographically absent lumen-mucosal surface. The ileum of dogs has a prominent submucosa (**FIGURE 4**).

Anatomically, the ileum is contiguous to the ileocecocolic junction in the cat, leading to the ascending colon. In the dog, there is a separate ileocolic junction and cecocolic orifice.

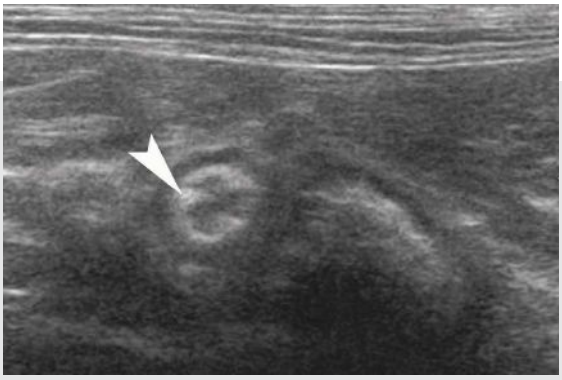

FIGURE 3. Short axis view of the ileum of a cat. Note the normal, prominent, hyperechoic submucosal layer (**white arrowhead**) and the normal, prominent, hypoechoic muscularis layer.

FIGURE 4. Long axis view of the ileum and ileocolic junction of a dog. Note the normal, prominent, hyperechoic submucosal layer (**white arrowhead**).

The normally gas filled cecum has an appearance similar to a segment of normal gas filled colon. In the normal dog cecum, the wall layers of the mucosa, submucosa, and muscularis have a uniform thickness.[13] Ultrasonographically, the normal feline cecum has a hypoechoic nodular inner layer (composed of multiple lymphoid follicles) and an adjacent hyperechoic submucosal layer.[8] The combined mucosal and submucosal layer is referred to as the follicular layer.

Colon

The colon is divided into three parts: ascending, transverse, and descending. The colon typically has the thinnest wall of all intestinal segments (**FIGURE 2**), and the wall layering is normally indistinguishable due to distension with gas and feces. Gas and feces are seen as hyperechoic reverberation artifact with irregularly marginated, hyperechoic, partial distal acoustic shadowing material. Foreign material within the small intestines should be distinguished from gas and feces within the colon.

An empty colon may appear undulating with distinguishable layers (**FIGURE 5**).

ILEUM ABNORMALITIES

Nonneoplastic Ileal Wall Thickening

Common inflammatory diseases affecting the ileum can be found in "Ultrasonography of the Gastrointestinal Tract: Stomach, Duodenum, and Jejunum" (January/February 2018) where duodenal and jejunal wall thickening was discussed.

FIGURE 5. Long axis view of the descending colon in a dog. In this case, the colon is empty, allowing identification of both the near and far walls of the colon (calipers) at the level of the urinary bladder.

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Malignant Ileal Neoplasms

Lymphoma is the most common intestinal neoplasm in the cat. It appears as a focal mass, multiple masses, or diffuse infiltrative neoplasia; characterized by thickening and/or loss of the normal layered appearance of the intestinal wall (**FIGURE 6**).[9,10,14]

Adenocarcinoma is the second most common intestinal neoplasm in the cat, appearing as a circumferential transmural thickening with a loss of normal intestinal layering. Predilection sites for adenocarcinoma in the cat are the jejunum and ileum.[15]

Mast cell tumor is the third most common intestinal neoplasm in the cat. It more commonly involves the small intestines, including the ileum, but can involve the ileo(ceco)colic region or the colon (**FIGURE 7**).[16,17]

Sonographic abnormalities of intestinal mast cell tumors in dogs have not been widely reported.

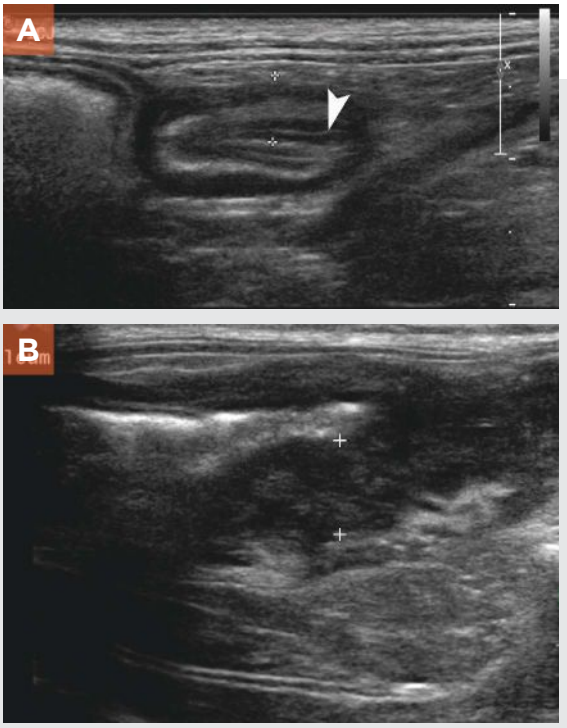

FIGURE 6. Long axis view of the ileocolic junction in a dog diagnosed with lymphoma (**A**). Note the overall thickness of the ileum (**calipers**), characterized by thickened submucosa and muscularis layers. There is an additional thin, hyperechoic structure traversing the mucosal layer of the ileum (**white arrowhead**), likely representing a region of fibrosis. Long axis view of the ileum in a cat diagnosed with lymphoma (**B**). Note the irregular margins, increased wall thickness (**calipers**), loss of wall layering, and the overall hypoechoic appearance.

Hemangiosarcoma is a rarely described cause of luminal narrowing in the ileum of cats.[18,19]

Benign Ileal Neoplasms

Leiomyoma cannot be differentiated from leiomyosarcoma using ultrasonography alone; cytologic or histopathologic diagnoses must be performed to confirm its diagnosis. Leiomyoma is uncommon in the cat.

CECUM AND COLON ABNORMALITIES

Intussusception

Most intussusceptions occur in young dogs and cats and are secondary to viral, bacterial, and parasitic etiologies.

An intussusception has a multilayered appearance in longitudinal axis and concentric ring appearance in transverse axis (**FIGURE 8**).[20-24]

Intussusceptions are named according to the segments involved; enteroenteric, ileocolic, and

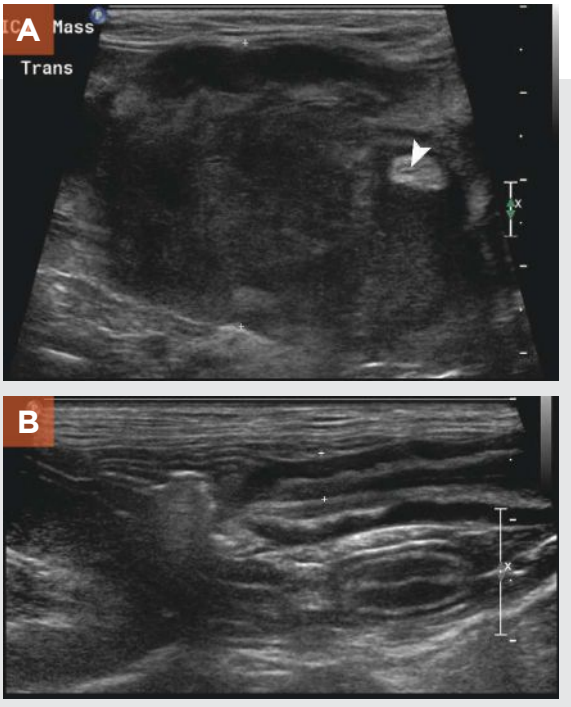

FIGURE 7. Short axis view of the ileocolic junction of a dog diagnosed with mast cell tumor (**A**). Note the irregularly marginated hypoechoic mass (**calipers**) circumferentially surrounding the ileal lumen (**white arrowhead**). Long axis view of the ileocecocolic junction of a cat diagnosed with mast cell tumor (**B**). Note the overall thickness of the ileum (**calipers**) and the thickened, hypoechoic muscularis layer.

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cecocolic intussusceptions are the most common types. An ileocolic intussusception is seen within the ascending and transverse colon. A cecocolic intussusception is short and localized to the area of the cecum and proximal ascending colon. A colocolic intussusception involves the colon only.

Malignant Neoplasms

Large intestinal neoplasms are not as common as small intestinal neoplasms. Adenocarcinoma[25] and lymphoma are most common large intestinal tumors in cats; other large intestinal tumors include mast cell tumor and hemangiosarcoma. Adenocarcinoma and leiomyosarcoma are most common large intestinal tumors in dogs.

Intestinal **adenocarcinoma** affects the cecum, colon, and mid-to-distal rectum of dogs. This intestinal neoplasia appears nodular, pedunculated, and may cause annular constriction.

Ultrasonographically, these neoplasms appear as circumferential transmural thickening with loss of normal intestinal layering (**FIGURE 9**).

Lymphoma commonly affects the cecum and colon in dogs.

Mast cell tumors can produce focal or diffuse wall thickening of the colon of cats.[16,17]

Leiomyosarcomas are considered the second most common canine intestinal tumor and the most common intestinal sarcoma in dogs.[26] Leiomyosarcoma causes large, eccentrically located, single or multiple, hypoechoic or anechoic area(s) of wall thickening.[27] They have a low incidence of developing in the cecum and colon (**FIGURE 10**).[28]

Leiomyosarcoma is uncommon in the cat.

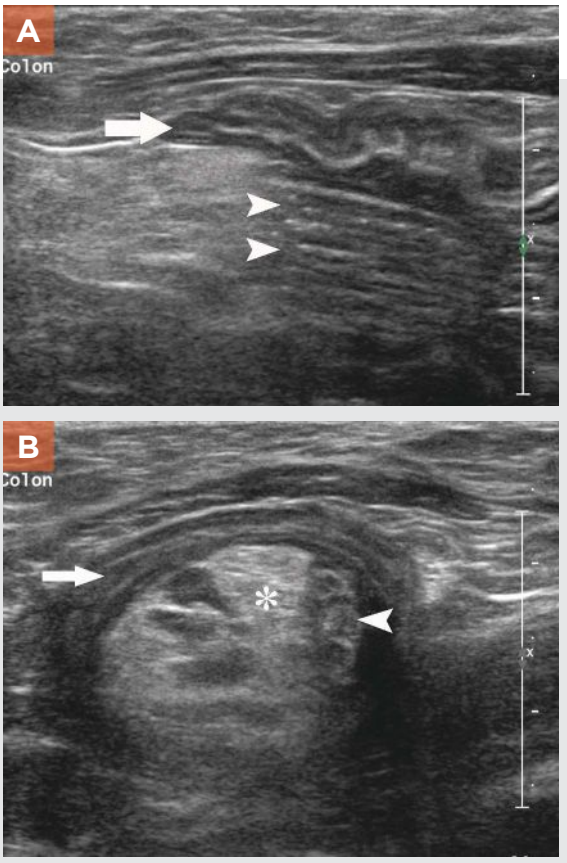

FIGURE 8. Long axis (**A**) and short axis (**B**) views of the colon of a cat diagnosed with a colocolic intussusception secondary to a colonic wall mass. Note the multilayered appearance of the colon and the hyperechoic mesentery within the center (*). The intussuscipiens (**white arrows**) and intussusceptum (**white arrowheads**) can be distinguished from one another.

FIGURE 9. Long axis view of the colon of a dog diagnosed with adenocarcinoma. Note the overall thickened wall (**calipers**), loss of layering, and hypoechoic appearance.

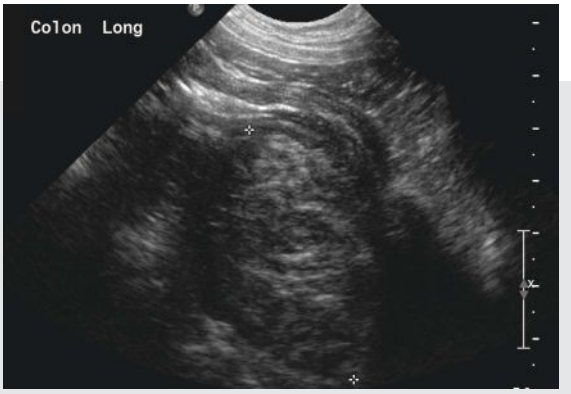

FIGURE 10. Long axis view of the colon of a dog diagnosed with a colonic leiomyosarcoma. Note the pedunculated, heterogeneous, eccentrically located mass associated with the wall of the colon (**calipers**).

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Hemangiosarcoma causes luminal narrowing and has been identified in the colon and rectum of cats.[18,19]

Gastrointestinal stromal tumors arise from the interstitial cells of Cajal; these are cells that regulate intestinal motility and peristalsis. They have histologic features similar to that of intestinal smooth muscle tumors but can be distinguished by immunohistochemistry.[29] The predilection sites for these tumors are the cecum and colon, whereas, smooth muscle tumors are more likely to be affect the stomach and small intestine.[29]

Gastrointestinal stromal tumor has been described in the feline jejunum as a hypoechoic mass with heterogeneous regions.[30]

Benign Neoplasms

Adenomatous polyps are infrequently seen lesions that have been identified in the rectum of dogs and small intestines of cats.[15,25] They appear as small, round to ovoid, mixed or varying echogenicity, pedunculated or broad based structures extending into the intestinal lumen; they can arise from the mucosal or submucosal surfaces.[31-34] There is a great potential for malignant transformation if they are large (**FIGURE 11**).

FIGURE 11. Long axis view of the descending colon and rectum of a dog diagnosed with an adenomatous polyp. Secondary to the mass protruding into the colonic lumen, note the focal thickening, loss of wall layering, and distortion of the hyperechoic gas interface.

FIGURE 12. Short axis view of the ileum of a cat diagnosed with eosinophilic sclerosing fibroplasia. Note the circumferential thickening of the muscularis layer (**white arrowhead**) of the ileum.

Nonneoplastic Wall Thickening

Nonmalignant diseases, such as histiocytic,[35] granulomatous,[36] and fungal[37] colitis, can cause focal wall thickening or masses.

Eosinophilic sclerosing fibroplasia has been described in the ileocecocolic junction and the colon of cats (**FIGURE 12**);[38,39] these lesions appear as masses or focal wall thickening with a loss of normal wall layering, similar to neoplastic lesions.[39]

Pythiosis can cause multifocal pyogranulomatous infections of the colon, causing focal wall thickening with a loss of wall layering, although an eccentric colonic mural mass was identified in one dog.[40]

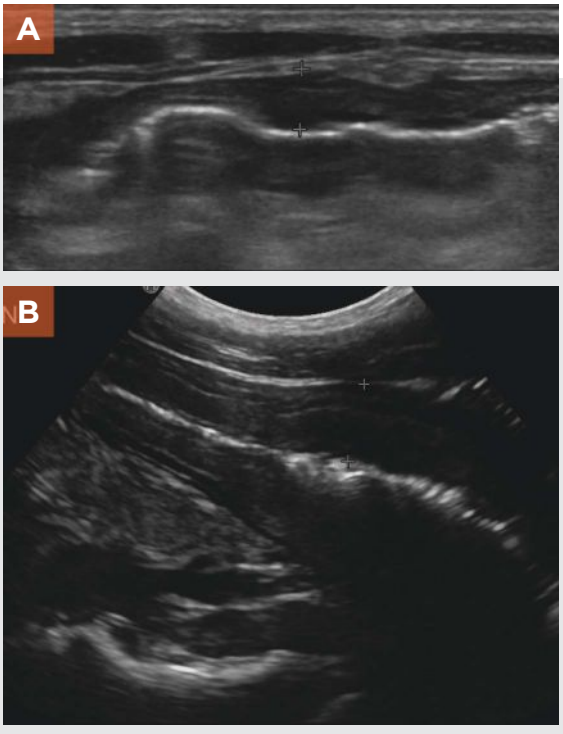

FIGURE 13. Long axis view of the colon of a cat diagnosed with severe pyogranulomatous colitis (**A**). Note the thickened wall and loss of wall layering. In cases with severe colitis, ultrasonographic appearances are indistinguishable from neoplastic infiltration. Long axis view of the colon of a dog diagnosed with epithelial hyperplasia and neutrophilic inflammation of the colon (**B**). Note the thickened but preserved layering of the wall.

Common intestinal **inflammatory bowel diseases**, such as lymphocytic-plasmacytic enteritis, are usually associated with mild to moderate wall thickening, affecting several or all intestinal segments with variable severity.[35,36] Other ultrasonographic features of intestinal inflammatory diseases include symmetric, mild to moderate wall thickening, affecting primarily the mucosa, submucosa, and/or muscularis layer; diffuse increased echogenicity of the mucosa; or presence of bright mucosal speckles (**FIGURE 13**).[41,42]

In severe cases of colitis, the wall layering may be altered or lost. Additionally, micronodular, submucosal hypoechoic and/or anechoic lesions measuring 1 to 3 mm in diameter, representing intraparietal lymphoid follicles, may be present in dogs and cats with inflammatory bowel disease.[43]

Differentiation between colitis and large intestinal infiltrative neoplasia may be difficult;[44] however, according to recent literature, dogs with intestinal tumors had significantly greater wall thickness, loss of wall layering, and more focal lesions than dogs with enteritis.[42] Ultimately, histopathology is required to differentiate between colitis and infiltrative neoplasia.[44]

SUMMARY

Common ultrasonographic abnormalities of the dog and cat gastrointestinal tract may have neoplastic or nonneoplastic etiologies and, once identified, may require further diagnostics for definitive diagnosis. A systematic examination of the gastrointestinal tract is a routine part of the complete abdominal evaluation. TVP

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References

1. Penninck DG, Nyland TG, Fisher PE, Kerr LY. Ultrasonography of the normal canine gastrointestinal tract. *Vet Radiol Ultrasound* 1989;30(6):272-276.
2. Newell SM, Graham JP, Roberts GD, et al. Sonography of the normal feline gastrointestinal tract. *Vet Radiol Ultrasound* 1999;40(1):40-43.
3. Goggin JM, Biller DS, Debey BM, et al. Ultrasonographic measurement of gastrointestinal wall thickness and the ultrasonographic appearance of the ileocolic region in healthy cats. *J Am Anim Hosp Assoc* 2000;36(3):224-228.
4. Stander N, Wagner WM, Goddard A, Kirberger RM. Normal canine pediatric gastrointestinal ultrasonography. *Vet Radiol Ultrasound* 2010;51(1):75-78.
5. Penninck DG, d'Anjou M. *Atlas of Small Animal Ultrasonography.* 2nd ed. Ames: Wiley Blackwell; 2015.
6. Di Donato P, Penninck D, Pietra M, et al. Ultrasonographic measurement of the relative thickness of intestinal wall layers in clinically healthy cats. *J Feline Med Surg* 2014;16(4):333-339.
7. Larson MM, Biller DS. Ultrasound of the Gastrointestinal Tract. *Vet Clin North Am: Small Anim Pract* 2009;39:747-759.
8. Hahn H, Pey P, Baril A, et al. Ultrasonographic, endoscopic and histological appearances of the caecum in cats presenting with chronic clinical signs of caecocolic disease. *J Feline Med Surg* 2017;19(2):94-104.
9. Mahony OM, Moore AS, Cotter SM, et al. Alimentary lymphoma in cats: 28 cases (1988-1993). *JAVMA* 1995;207(12):1593-1598.
10. Penninck DG, Moore AS, Tidwell AS, et al. Ultrasonography of alimentary lymphosarcoma in the cat. *Vet Radiol Ultrasound* 1994;35(4):299-306.
11. Gladwin NE, Penninck DG, Webster CR. Ultrasonographic evaluation of the thickness of the wall layers in the intestinal tract of dogs. *Am J Vet Res* 2014;75(4):349-353.
12. Winter MD, Londono L, Berry CR, Hernandez JA. Ultrasonographic evaluation of relative gastrointestinal layer thickness in cats without clinical evidence of gastrointestinal tract disease. *J Feline Med Surg* 2014;16(2):118-124.
13. Besso JG, Rault D, Begon D. Feline cecum and ileocecocolic junction: normal ultrasonographic features and clinical applications (abstract). *Vet Radiol Ultrasound* 2004;45:599.
14. Grooters AM, Biller DS, Ward H, et al. Ultrasonographic appearance of feline alimentary lymphoma. *Vet Radiol Ultrasound* 1994;35(6):468-472.
15. Tams TR. *Handbook of Small Animal Gastroenterology*. 2nd ed. St. Louis: Saunders; 2003.
16. Sato AF, Solano M. Ultrasonographic findings in abdominal mast cell disease: a retrospective study of 19 patients. *Vet Radiol Ultrasound* 2004;45(1):51-57.
17. Laurenson MP, Skorupski KA, Moore PF, Zwingenberger AL. Ultrasonography of intestinal mast cell tumors in the cat. *Vet Radiol Ultrasound* 2011;52(3):330-334.
18. Sharpe A, Cannon MJ, Lucke VM, Day MJ. Intestinal haemangiosarcoma in the cat: clinical and pathological features of four cases. *J Small Anim Pract* 2000;41(9):411-415.
19. Culp WT, Drobatz KJ, Glassman MM, et al. Feline visceral hemangiosarcoma. *J Vet Intern Med* 2008;22(1):148-152.
20. Penninck DG, Nyland TG, Kerr LY, Fisher PE. Ultrasonographic Evaluation of Gastrointestinal-Diseases in Small Animals. *Vet Radiol Ultrasound* 1990;31(3):134-141.
21. Larson MM, Biller DS. Ultrasound of the gastrointestinal tract. *Vet Clin North Am Small Anim Pract* 2009;39(4):747-759.
22. Garcia DA, Froes TR, Vilani RG, et al. Ultrasonography of small intestinal obstructions: a contemporary approach. *J Small Anim Pract* 2011;52(9):484-490.