Practical SMALL ANIMAL ultrasonography

2nd EDITION

Abdomen

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VIDEOS INCLUDED

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Scanning technique

The animal is positioned in right lateral recumbency with the head pointing towards the ultrasound machine and the limbs towards the examiner.

The stomach is located just caudal to the liver as the transducer is moved along the last rib towards the spleen. Most of the gastrointestinal tract can be evaluated in right lateral recumbency. Sometimes, the animal also needs to be positioned in left lateral recumbency in order to examine the pyloric region of the stomach and part of the small intestine. This is particularly relevant in large-sized dogs, where due to increased animal size and increasing scanning depth, complete evaluation from one side is not possible.

Most of the gastrointestinal tract can be examined using a 7-8 MHz transducer. In small dogs, and especially in cats, a 10 MHz (or higher) transducer is commonly employed. In large dogs, sometimes a 6, 5 or 4 MHz transducer may be useful due to the increased scan depth that is required.

Stomach

1. From the liver, with the marker of the transducer pointing to the head of the animal, slide the transducer towards the left of the animal along the last rib, feeling the rib cranial to the transducer. The stomach can be identified just caudal to the liver.

2. The first image is along the short axis of the stomach (Fig. 1).

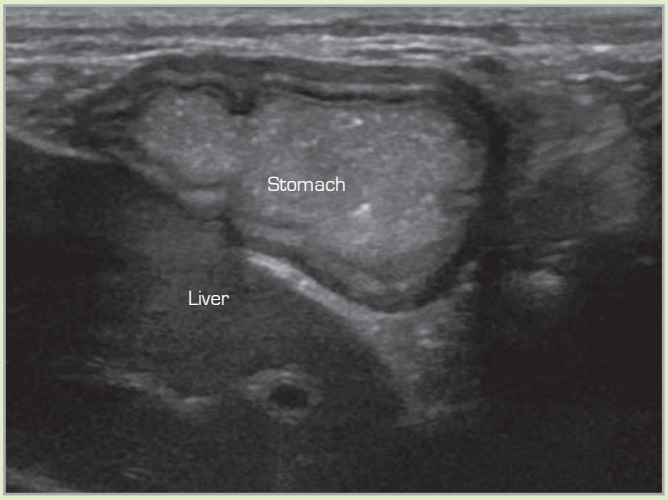

Figure 1. View along the short axis of the stomach. Some rugal folds are visible.

3. Fan and slightly slide the transducer dorsally towards the spine to evaluate the body and fundus of the stomach (Fig. 2a) and then fan and slightly slide the transducer ventrally (Fig. 2b) for the examination of the pyloric region.

4. Rotate the transducer clockwise, approximately 90° or slightly less, until you get a longitudinal view of the stomach in which the stomach appears to run across the screen with the fundus to the left and the pylorus to the right side of the screen (Fig. 3).

5. Rocking of the transducer dorsally (Fig. 4a) and ventrally (Fig. 4b) allows examination of the stomach in long axis.

When examining the stomach, it is a good idea to keep the transducer still for one minute to observe the gastric contractions and evaluate their strength and frequency.

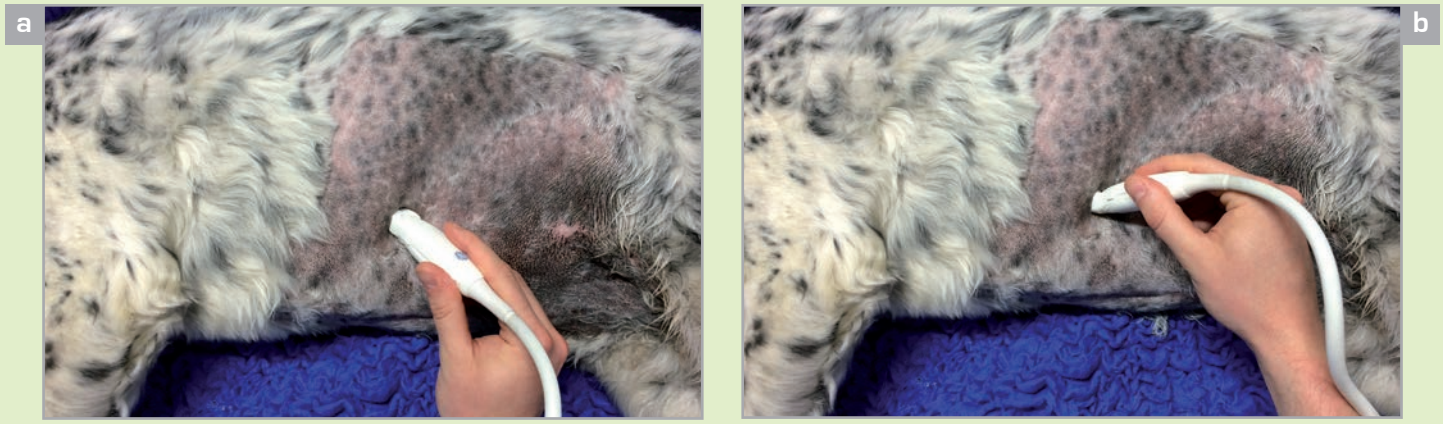

Figure 2. After identifying the stomach on the screen, and with the marker pointing to the head of the animal, the transducer is fanned up **(a)** and down **(b)** to evaluate the stomach in short axis.

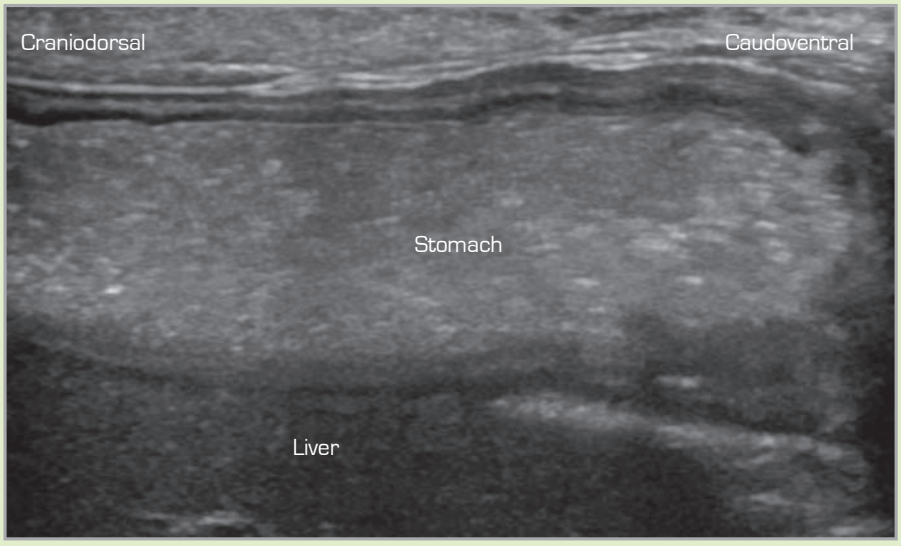

Figure 3. View along the long axis of the stomach. The gastric wall layers are clearly visible.

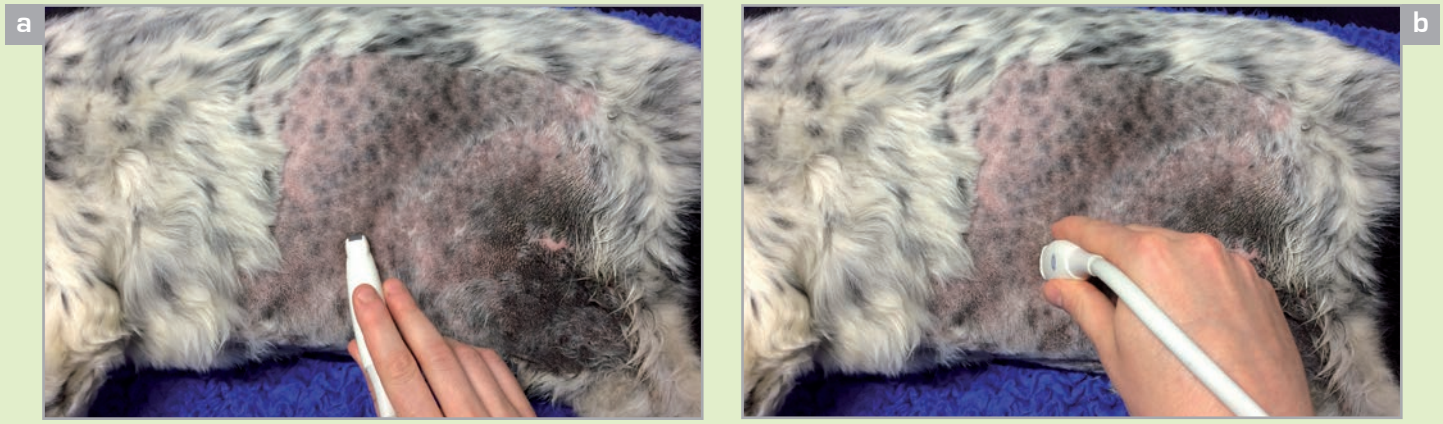

Figure 4. The stomach is evaluated along its long axis by rocking the transducer up **(a)** and down **(b)**.

Small intestine

1. It is almost impossible to ultrasonographically follow all the small intestine from the duodenum to the ileum, so the objective is to follow a specific pattern and try to examine any loop that is visible.

2. With the marker pointing to the head of the animal, and starting from the stomach, slide the transducer in a caudal direction following a "castle" pattern (Fig. 5), until you see the urinary bladder on the screen.

3. Examine every loop that comes into view on the screen and try to identify the lumen and layers of the intestine (Fig. 6).

4. If a loop appears thickened, measure the intestinal wall thickness from the inner mucosa to the inner serosa.

5. The duodenum can be identified and evaluated. The technique to identify the duodenum will be described in the Pancreas chapter.

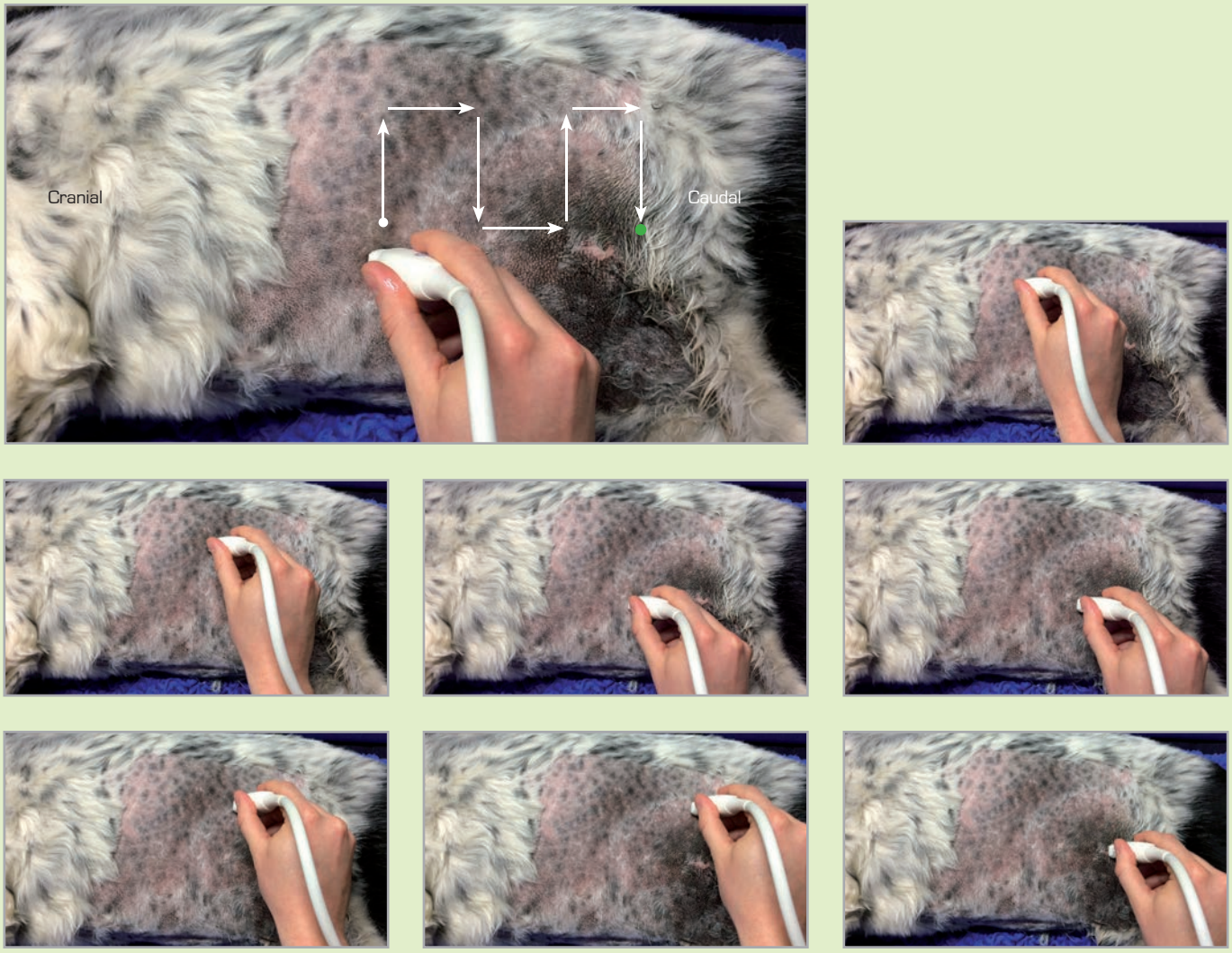

Figure 5. To evaluate the intestine, hold the transducer with the marker pointing to the head of the animal. Then, start at the level of the stomach and slide the transducer dorsally, caudally, ventrally, caudally and then dorsally again. Repeat the movement following a "castle" pattern in a caudal direction, until you reach the level of the urinary bladder. While sliding the transducer, any loop of intestine, lymph node and mesenteric tissue that comes to view is evaluated.

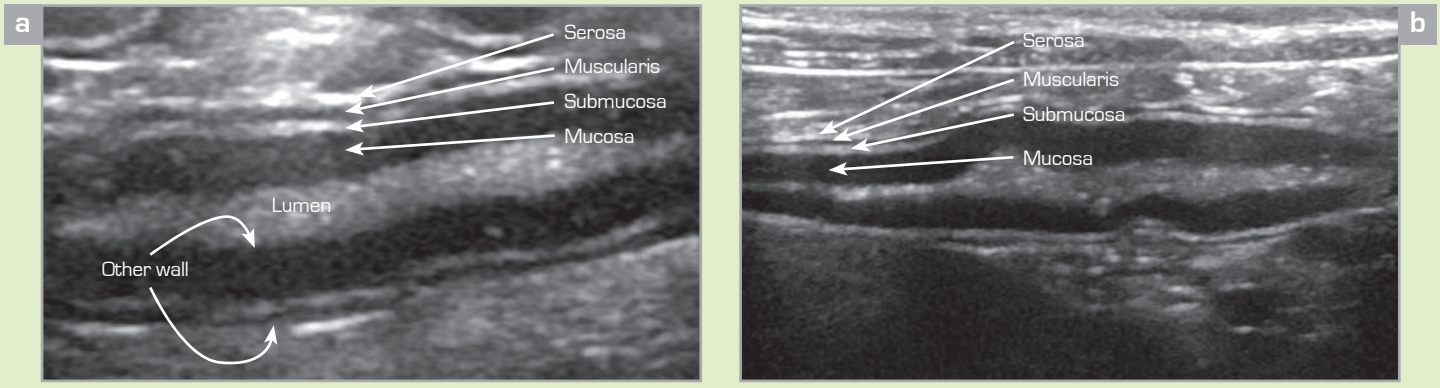

Figure 6. (a) Jejunal loop in a healthy cat. Intestinal layering is clearly visible in this normal intestine (hypoechoic mucosa, hyperechoic submucosa, hypoechoic muscularis and hyperechoic serosa). **(b)** Duodenum in a healthy dog. The layers of the wall are clearly identifiable.

Large intestine

1. Identify the urinary bladder and slide the transducer (with the marker pointing to the head of the animal) dorsally, towards the spine, and identify the descending colon, which is dorsal to the urinary bladder (Fig. 7). The descending colon can be identified by its location, thin wall and the artefacts caused by the gas and faeces in it.

> The lumen of the colon usually contains faeces and gas that produce artefacts.

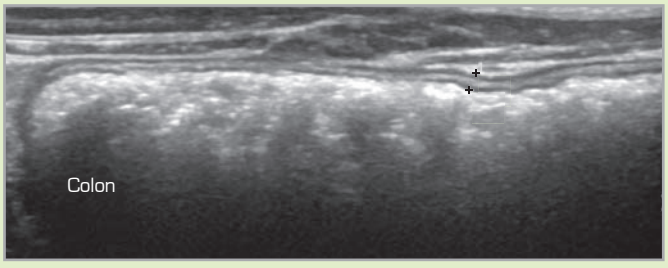

Figure 7. Normal colon in a dog. Its wall (between callipers) is thin (up to 2 mm thick) compared with the small intestine. The layers of the colon (hypoechoic mucosa, hyperechoic submucosa, hypoechoic muscularis and hyperechoic serosa) are clearly visible.

2. Slowly slide the transducer cranially to follow the descending colon and then examine the transverse and ascending colon. At the level of the transverse colon, some rotation of the transducer is required to achieve optimal alignment.

3. When at the level of the transverse to ascending colon, some rotation of the transducer will be required again to achieve optimal alignment.

4. Following the ascending colon caudally, the ileocaecocolic junction (Fig. 8) appears on the screen, where the small intestine (with a more prominent, thicker wall and a thicker mucosa) is visible in contrast to the colonic wall which is thinner.

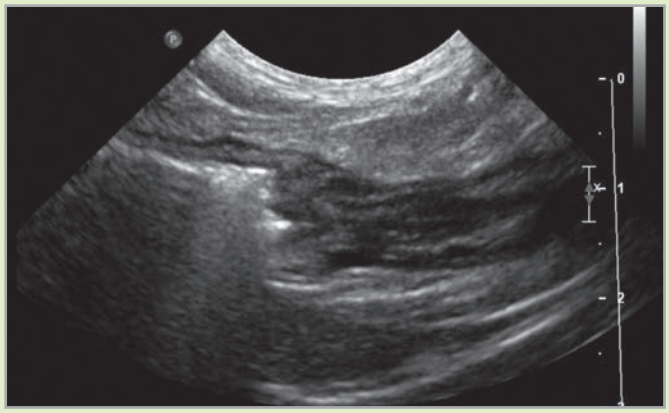

Figure 8. The normal ileocaecocolic junction in a 7-year-old Yorkshire Terrier.

Normal appearance

Wall thickness should be evaluated in order to establish whether the gastrointestinal tract is ultrasonographically normal (Table 1).

Table 1. Maximum normal wall thickness of the gastrointestinal tract in the dog and cat.

Segment of the gastrointestinal tract	Dog	Cat
Stomach	5 mm	2 mm
Small intestine (duodenum)	5 mm	2–3 mm
Small intestine (rest of the segments)	4 mm	4 mm
Large intestine	2 mm	2 mm

Stomach

The stomach varies in size depending on the amount of ingesta it contains. The normal thickness of the gastric wall is up to 5 mm in the dog and up to 2 mm in the cat (see Table 1).

Gastric wall thickness should be measured between the gastric rugal folds.

The layers of the gastric wall can usually be identified. The mucosa is hypoechoic, the submucosa is hyperechoic, the muscularis is hypoechoic and the serosa is hyperechoic (see Figs. 1 and 3). The rugal folds are commonly visible and more clearly identifiable in an empty stomach. The stomach contracts on average once every 12 seconds or approximately 5 times a minute during feeding.

Small and large intestine

The intestinal layers can be easily identified in the normal intestine. The mucosa is hypoechoic, the submucosa is hyperechoic, the muscularis is hypoechoic and the serosa is hyperechoic (see Figs. 6 and 7). The intestinal wall should be measured from the inner mucosal margin to the inner serosal margin (Fig. 9).

The duodenum has the thickest wall and can normally measure up to 5 mm in the dog and up to 3 mm in the cat. The duodenal papilla can also be identified as a small tubular structure in longitudinal view and as a rounded structure in transverse view (Fig. 10). Mucosal indentation corresponding to the Peyer patches can be seen sometimes in the antimesenteric border of the duodenum (Fig. 11). The rest of the small intestine has been reported to be up to 3 mm thick (especially in cats), although the author prefers 4 mm as a cut-off measurement for normal for dogs and cats. The ileum in cats has a distinctive “wagon wheel” appearance in transverse view.

The ileocaecocolic junction can, and should, be evaluated in dogs and cats. It is commonly easy to identify in dogs and cats (Fig. 8) though in dogs sometimes gas in the caecum creates difficulties.

The small intestine normally has one to three peristaltic contractions per minute, while no peristaltic contractions are usually seen in the colon.

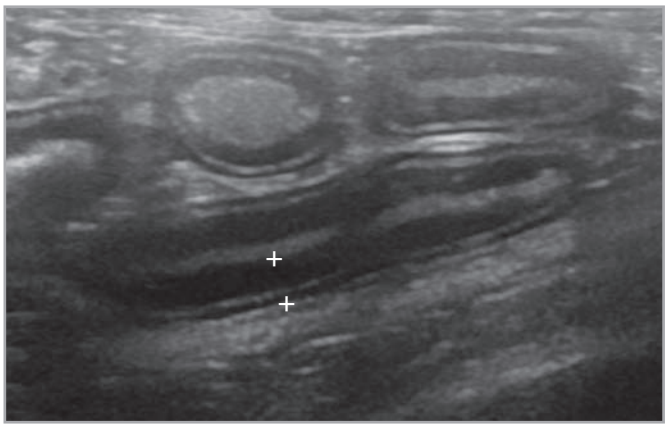

Figure 9. Wall measurement of a normal jejunal loop in a cat. The callipers are placed from the mucosal surface to the inner serosa.

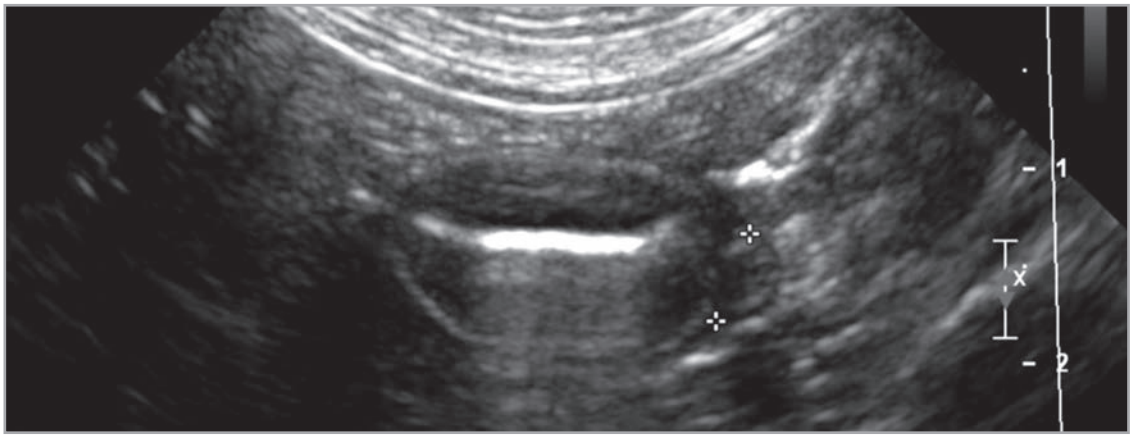

Figure 10. Normal duodenal papilla (between callipers) in a 9.5-year-old, Staffordshire Bull Terrier, transverse view.

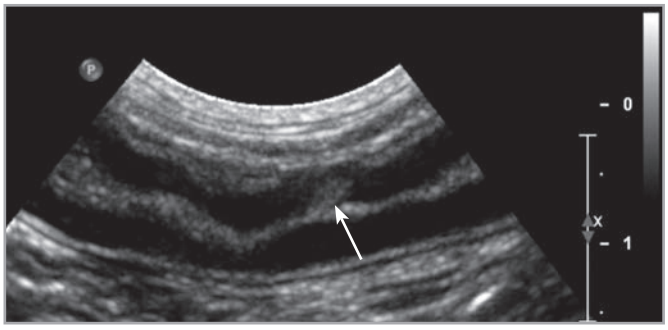

Figure 11. Mucosal indentation at the antimesenteric border of the duodenum from a dog, corresponding to a Peyer patch.

Variations from normal

Stomach

As the stomach can be filled with gas, fluid, ingesta or any combination of these, it can appear more or less distended on ultrasound examination. In a distended stomach it is important to assess the frequency of any contractions and to search for any evidence of obstruction and/or wall thickening. The pylorus should also be evaluated for adequate passing of gastric contents to the duodenum.

Gastric foreign bodies can be diagnosed as an incidental finding or as the cause of the clinical signs exhibited by the patient (vomiting, anorexia, etc.). Foreign bodies commonly have a hyperechoic surface and acoustic shadowing (Fig. 12). Linear foreign bodies may appear as a hyperechoic line that can extend caudally to the duodenum and the rest of the small intestine.

Gastric wall thickening can be associated with malignant and non-malignant diseases. Malignant diseases usually cause focal thickening with disruption or loss of the layers (Fig. 13), while non-malignant diseases commonly cause a more generalised wall thickening with retention of the wall layers (Fig. 14).

Uraemic gastritis appears ultrasonographically as a thickened gastric wall with prominent rugal folds and a hyperechoic line in the inner mucosa (luminal side) consistent with mucosal mineralisation (Fig. 15).

Gastric ulceration can be identified on ultrasound as a hyperechoic defect within the mucosa due to the accumulation of gas microbubbles and blood clots (Fig. 16). If the ulcer is perforated, hyperechoic mesentery around the area may be seen along with free peritoneal gas and fluid.

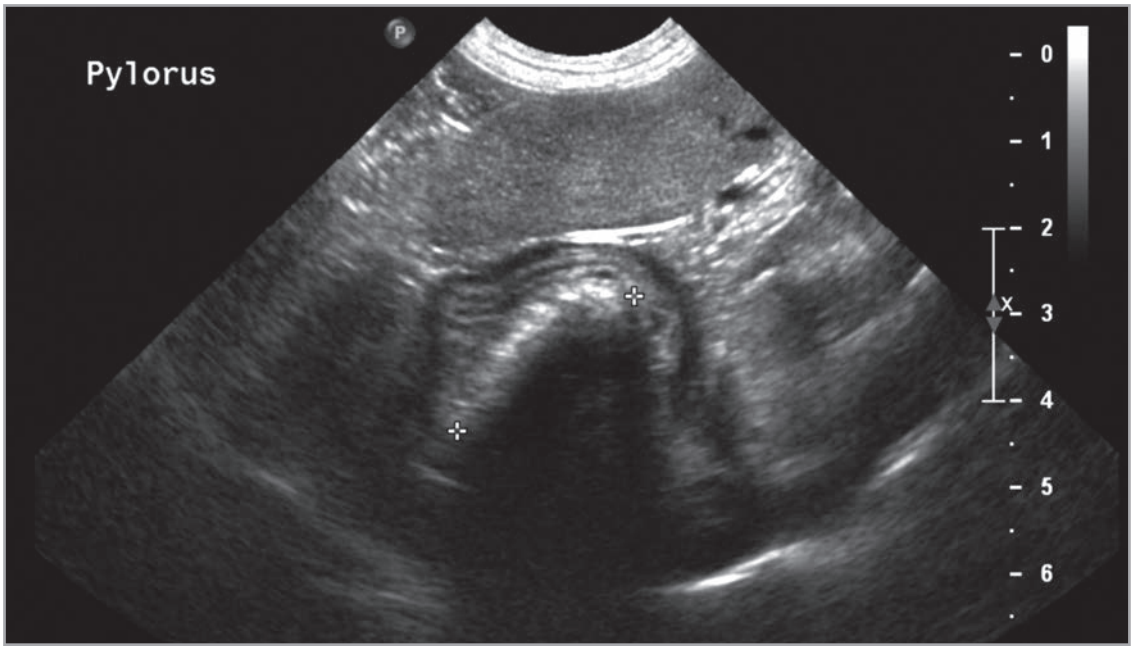

Figure 12. Gastric foreign body (between callipers) in the stomach of a 7-year-old Springer Spaniel. This foreign body with the hyperechoic surface and the strong acoustic shadowing was a corncob in the pylorus of the stomach.

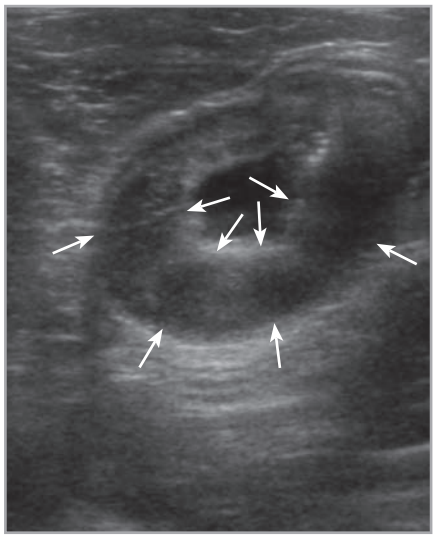

Figure 13. 11-year-old cat diagnosed with gastric lymphoma. There is focal thickening of the gastric wall, which appears hypoechoic with loss of layering (between arrows).

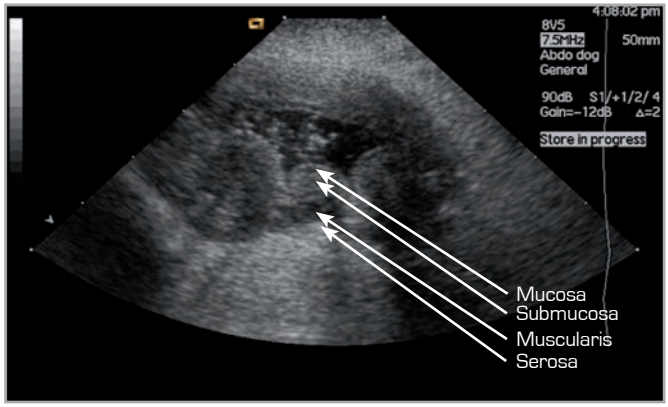

Figure 14. Image along the short axis of the stomach in a dog presented with gastritis. Note the increased thickness of the gastric wall, especially the thickness of the submucosa and the muscularis, with a retained, although abnormal, layered appearance.

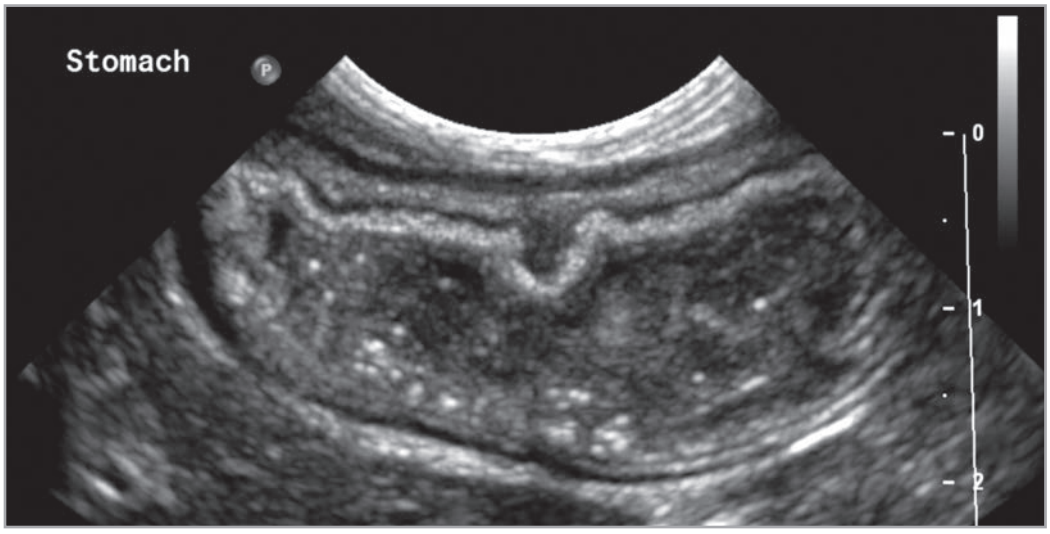

Figure 15. Uraemic gastritis in a 19-month-old dog.

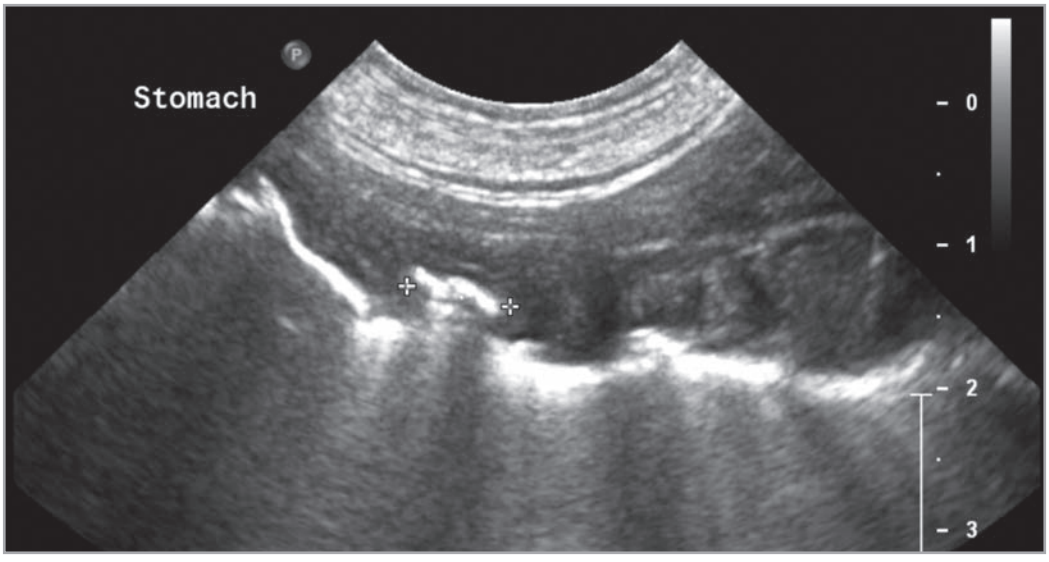

Figure 16. Gastric ulcer in the stomach a 5.5-year-old male German Shepherd dog. Flat hyperechoic depression in the gastric wall is present (between callipers).

Small and large intestine

Ultrasonography is very sensitive in the identification of intussusception. The intussusceptum and intussuscipiens create a multilayered appearance ("multiple rings" sign on transverse views and "too many layers" sign on longitudinal views) (Fig. 17). Occasionally, fat and lymph nodes may also be involved in the intussusception.

Although it may be more challenging to identify, gastroduodenal or duodenogastric intussusception can also be identified on ultrasound examination.

Intestinal dilatation can be associated with functional (Fig. 18) or mechanical ileus (Fig. 19):

- Functional ileus: generalised intestinal dilatation may be seen in cases of severe gastroenteritis, generalised peritonitis, postoperative abdomen, pain, drugs, or electrolyte imbalances. In these cases, a relatively uniform intestinal dilatation can be seen.
- Mechanical ileus: it commonly causes local dilatation of the intestine; however, it can also result in a more generalised dilatation if it is located more caudally. Partial intestinal obstruction causes less marked dilatation of the intestine cranial to the obstruction. Artefacts caused by the material lodged cranial to the obstruction sometimes obscure the identification of the exact cause. Intestinal foreign bodies are a common cause of mechanical ileus and can often be identified ultrasonographically (Fig. 19A). The ultrasonographic appearance is that of a hyperechoic surface with distal acoustic shadowing. The geometric shape or pattern can provide information as to the exact shape and type of foreign body. A linear foreign body commonly appears in the ultrasound image as a linear hyperechoic line in the lumen involving many loops and causing plication of the bowel (Fig. 20). Gastrointestinal parasites can appear as linear foreign bodies; however, acoustic shadowing is usually not observed with adult parasites.

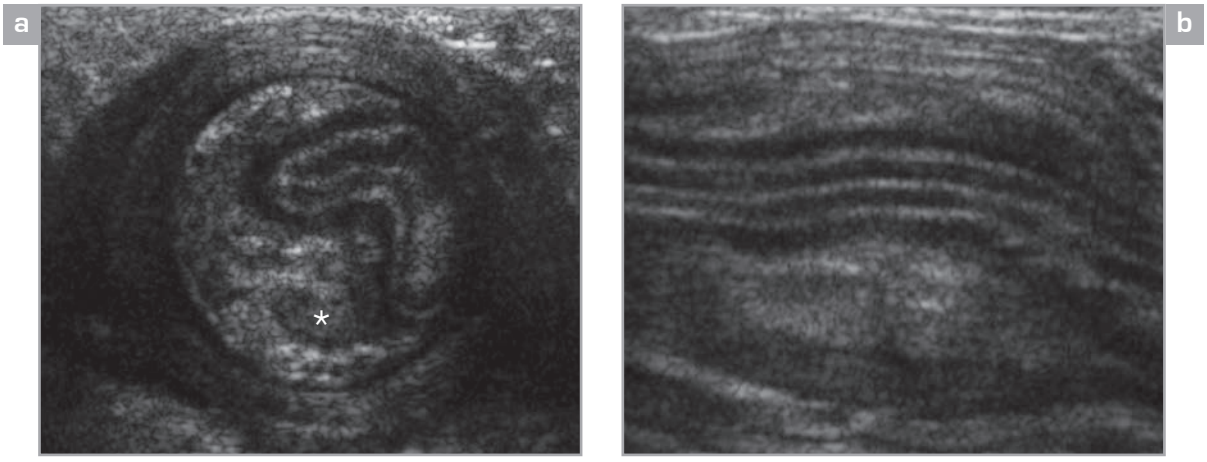

Figure 17. Intussusception in a dog. **(a)** Observe the "multiple rings" sign on the transverse image with a loop of intestine within another. A lymph node (*) and mesenteric tissue are visible within the intussuscipiens. **(b)** Longitudinal view of the same intussusception where the "too many layers" sign is visible.

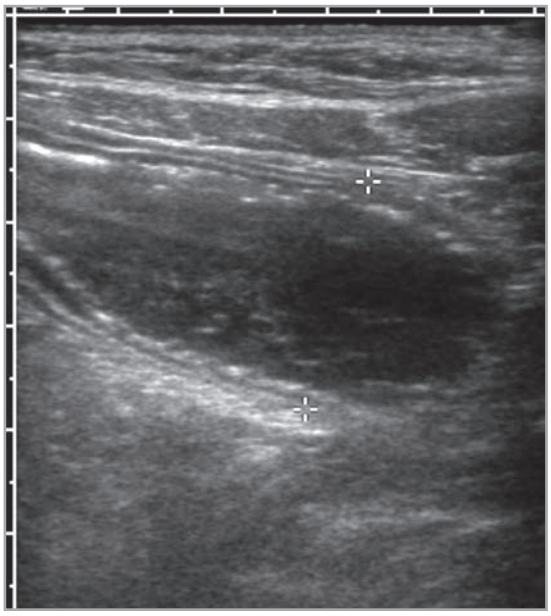

Figure 18. Dilated and fluid-filled loop of jejunum (between callipers) in a dog that had generalised small intestinal dilatation with fluid-filled bowel, compatible with functional ileus.

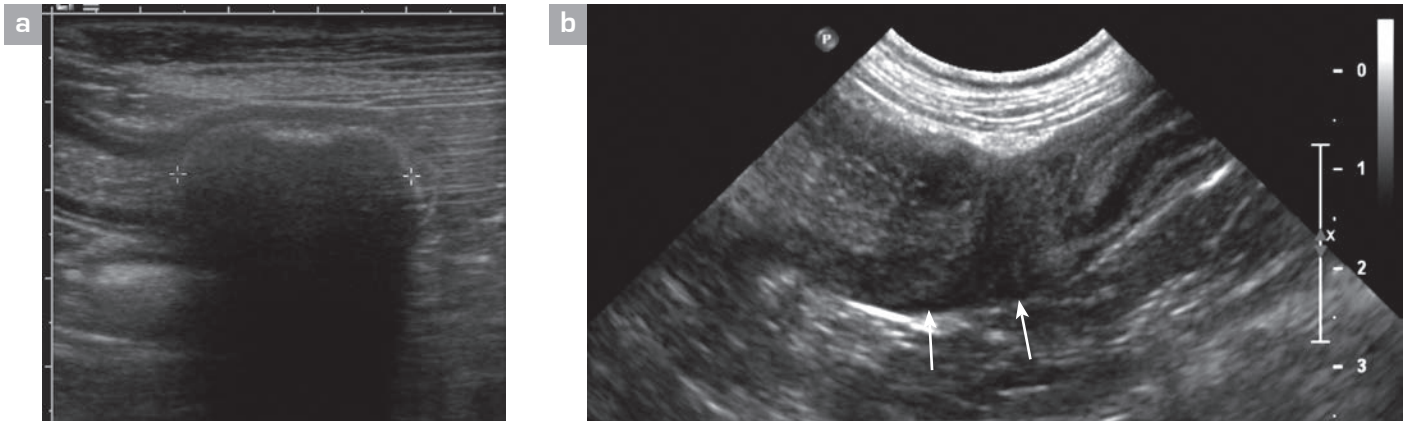

Figure 19. (a) Small intestinal foreign body (fruit stone, between callipers) in a dog causing partial small intestinal obstruction. Note the hyperechoic surface and distal acoustic shadowing. **(b)** Annular jejunal mass (arrows) associated with mechanical ileus in a 10-year old Labrador Retriever. The mass was confirmed on histopathology as adenocarcinoma.

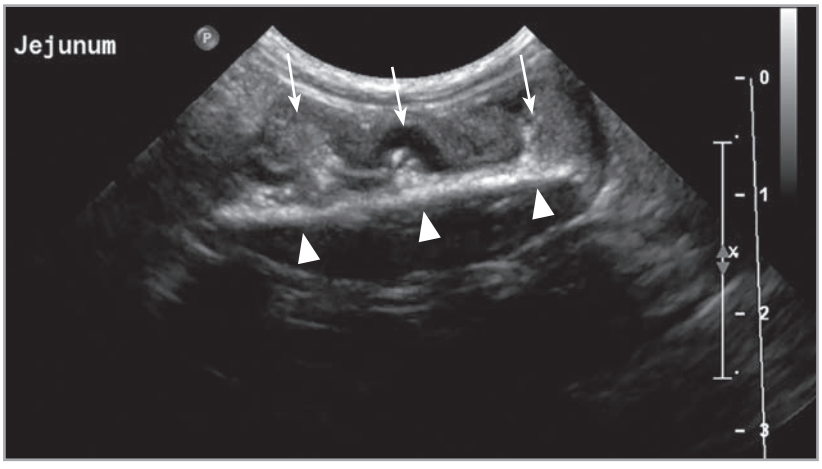

Figure 20. Jack Russel Terrier 7-year-old with a linear foreign body (rope). The foreign body is visible in the jejunum as a linear hyperechoic structure in the lumen (arrowheads), causing plication (long thin arrows).

Corrugated intestinal wall can be seen in cases of enteritis, peritonitis, pancreatitis (Fig. 21), neoplasia, intestinal wall ischaemia and intestinal lymphagiectasia.

Intestinal wall thickening can be seen with malignant and non-malignant diseases. Malignant lesions are usually focal and cause loss or disruption of the intestinal wall layers (Fig. 22), while non-malignant lesions tend to cause a more diffuse thickening with preservation of the intestinal wall layering. However, lymphosarcoma can be either diffusely infiltrative or cause focal lesions. In cases of rupture of the intestinal wall, focal peritoneal changes may be detected ultrasonographically.

Finally, another pattern worth mentioning is the linear mucosal hyperechoic lines perpendicular to the long axis of the intestine. This appearance has been associated with lacteal dilatation (Fig. 23), mucosal inflammation and protein-losing enteropathy, lymphagiectasia and, occasionally, with diffusely infiltrative tumours.

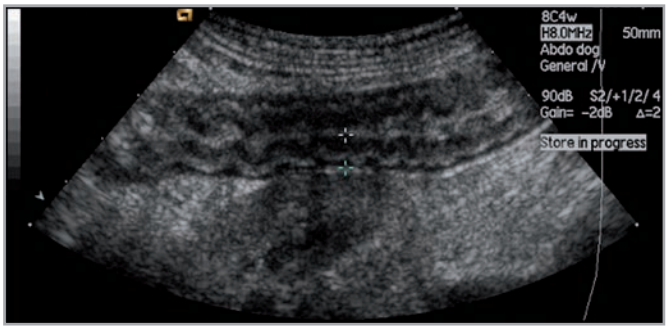

Figure 21. Corrugated duodenal wall in a dog diagnosed with pancreatitis.

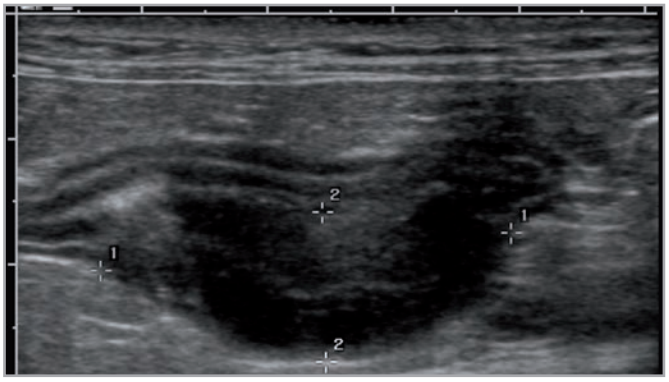

Figure 22. Intestinal lymphoma in a cat. Note the focally thickened, hypoechoic small intestine wall (between callipers) with loss of the normal layered appearance that is still preserved in other parts of the wall of this loop.

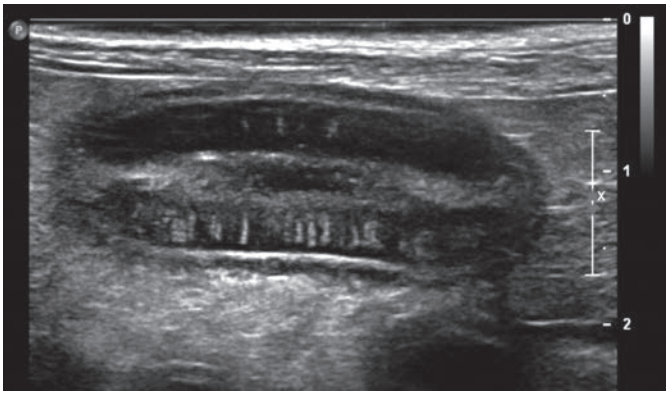

Figure 23. Linear mucosal hyperechoic lines perpendicular to the long axis of the intestine in a dog. These likely represent dilated lacteals.