Competing or complementary? Use of radiography and ultrasonography

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MONICA MERLO considers the best use of radiographic and ultrasonographic imaging, focusing on how the techniques can be mixed and matched

Summary

What is the best way to find a gastric or intestinal obstructing foreign body? There is no foolproof answer, but radiology and sonography can be of great help. A good knowledge of normal anatomy and anatomical variation, together with being familiar with the normal radiographic and sonographic findings represent a good starting point. Some foreign bodies are easier to detect than others. Changing the position of the patient can shift fluid and gas content in the gastrointestinal tract, creating a different appearance in both radiograph and ultrasound. In radiographs, a foreign body may be visualised if surrounded by gas in the gastrointestinal lumen. In ultrasound, a foreign body may become apparent when surrounded by fluid in the gastrointestinal tract. Radiographic and sonographic signs of intestinal obstruction vary with time and repeating radiographs and ultrasound after a few hours can sometimes make a difference in visualising a foreign body.

Key words

foreign body, stomach, intestine, obstruction, small animals

WHAT is the best way to find a gastric or intestinal obstructing foreign body?
Unfortunately, there is no 100 per cent correct answer, because several factors need to be taken into account.

For example, who is the person answering the question – different radiologists have different opinions and experiences. What kind of foreign body are we talking about – radiopaque versus radiolucent. Where is the foreign body – stomach versus small intestine? How long has the foreign body been in the gastrointestinal tract – the longer it stays, the more marked the mechanical obstruction is and sometimes easier to find.

We can optimise our chances of success by knowing what to look for (secondary changes) and performing our best imaging technique.

The other obvious dilemma is choosing between radiology and ultrasound. The author’s approach is to mix-and-match them as needed.

We often end up performing both as they really complement each other. The choice of which you want to start with is personal and depends on your equipment, skills and the patient.

I will briefly describe normal and abnormal findings for radiology and ultrasound, dividing them into gastric and intestinal foreign bodies.

**Stomach**

- **Normal radiographic findings**

  The radiographic appearance of the stomach varies, depending on species, breed, age, distension and position of the patient. Only a brief description will be given here (more details can be found in the references).

  The normal stomach lies across the abdomen with the fundus on the left and the pyloric antrum to the right of the midline. On a ventrodorsal (VD) radiograph, the stomach has a J shape. On a lateral view, the gastric axis from the fundus to the pylorus is perpendicular to the spine or parallel to the ribs (or somewhere between these angles).

  The radiographic appearance and size of the stomach change according to its repletion state, amount of ingesta, gas and fluid.

  The patient’s position also affects the radiographic appearance of the stomach, as the gas and fluid content move into different areas according to gravity (fluid settles to the dependent area and gas rises to the highest area). For example, on a VD view (patient in dorsal recumbency) the gas will occupy the pyloric antrum (upper area). A similar effect with gas in the pyloric antrum is also visible when the patient is placed in left lateral recumbency, while the gas accumulates in the...
fundus and body when the patient is in right lateral recumbency (the pyloric antrum is fluid-filled).

The gastric wall and rugal folds are not properly evaluated on survey radiographs because the fluid content shows the same radiopacity as the wall itself. Therefore, the gastric wall is best examined with radiographic contrast studies or ultrasound (Thrall, 2012).

• **Normal ultrasonographic findings**

The appearance of the stomach varies with the amount of gas and content. An empty stomach may look like a “flower” (also described in literature as a “wagon wheel”), especially in cats. The five layers of the wall are well visualised with ultrasound and the thickness can be measured (normal thickness is 3mm to 5mm in dogs and 2cm to 2.6cm in cats). Peristalsis can be seen and four to five contractions per minute are considered normal (Penninck, 2008).

• **Gastric foreign bodies**

Radiopaque foreign bodies in the stomach are easily identified with survey radiographs and will not be discussed.

The usual challenge is from soft tissue opacity foreign bodies (such as rubber, toys or fabric) and these may be disguised by food and fluid content in the stomach.

The easy and basic approach is to take a series of different views (right and left lateral, VD, dorsoventral) as this will displace the gastric gas bubble and the fluid and may (or not) highlight the foreign body. It is worth a try as this is an easily performed test. If this fails to show a foreign body then, depending on personal experience, preference, personal technical skills and available time and staff, a radiographic contrast study or ultrasound can be performed. In theory, it is possible to perform both techniques, keeping in mind gas and barium will interfere with the sonographic examination.

If the patient is not critically ill, another approach could be to wait 12 to 24 hours (starving the patient) and repeat the radiographs; sometimes gas, fluid and foreign bodies move and it may be easier to detect them. This would also allow an assessment of the degree of obstruction (the stomach will be more distended in case of complete obstruction). A small amount of positive contrast medium (barium) or gas can be administered to highlight a foreign body (Thrall, 2012).

Seldom do I give negative or positive contrast as I find it easier and quicker to perform a sonogram. If this fails to demonstrate a foreign body, but signs of obstruction are found, I tend to recheck the patient after six to 12 hours. Sonographic signs of gastric foreign bodies vary with the size/type of object and with the degree of obstruction (if present). The ability to detect foreign objects with ultrasound depends on factors such as stomach content, position and composition of the object.
The main feature of gastric outflow obstruction is, obviously, dilation of the organ usually with increased fluid content and reduced or absent peristalsis. A thorough examination from different windows and changing the patient position should help. Foreign bodies usually create a strong acoustic shadow with a hyperechoic interface. They can have different shapes, but these are very often hard to see unless the composition of the object allows sound penetration (some kind of plastic/rubber for example). Adding water to the stomach may help visualise the object, but this can be suboptimal if the patient is acutely vomiting.

**Small intestine**

- **Normal radiographic findings**

The roentgen signs assessment for the small bowel are definition of serosal surfaces (margins), diameter of the lumen (size), location with abdominal cavity (position), contour of the loops (shape) and lumen contents (radiopacity). Wall smoothness and motility can be evaluated with contrast studies and/or ultrasound.

Intestinal serosal surfaces are visible when there is no superimposition of loops and some intraperitoneal fat – they should be smooth.

The normal diameter of the lumen in dogs is variable and it has been reported to be less than 1.6 times the height of the body of L5 or twice the width of a rib. In cats, it has been reported to be less than 12mm or twice the height of the body of L4.

The cranial duodenal flexure is fixed by the hepatoduodenal ligament and the descending duodenum runs along the right abdominal wall. The jejunum is not fixed and occupies the free space in the peritoneal cavity. The normal small bowel is seen in survey radiographs as smooth, continuously curving “tubes” or as circles.

The radiopacity of the bowel depends on its content. In normal patients, gas, fluid and mottled ingesta can be normally seen in the lumen. In fasted dogs, gas can be as much as 30 per cent to 60 per cent of the content, while in cats it is usually less (Thrall, 2012).

- **Normal ultrasonographic findings**

As for the stomach, the ultrasonographic evaluation of the small intestine can be impaired by its content. I usually find it useful to return on the same loop after a few minutes as gas and content may move quickly. Changing patients’ recumbency and windows is also effective.

A high frequency probe (greater than 7.5 MHz) is used to assess wall thickness. This varies in cats and dogs and with a dog’s size. As a general rule, cats’ small intestinal wall thickness should be less than 2.4mm; dogs’ wall thickness should be less than 4.4mm; the duodenal wall is slightly
thicker than the jejunal one.

The layers should be well defined and visible. The mucosa is hypoechoic and thicker than the other layers, the submucosa is thin and hyperechoic, the muscularis is thin and hypoechoic and the serosa is thin and hyperechoic.

The normal duodenum can be identified and followed superficially along the right flank, while the jejunum and most of the ileum are seen as non-descriptive loops.

Peristalsis can be seen and two to three contractions per minute are normal. Gas content may create prominent reverberation (“comet tail”) artefacts (Penninck, 2008).

• **Intestinal foreign bodies**

Radiopaque foreign bodies in the intestine are easily identified with survey radiographs and will not be discussed. The term “ileus” indicates failure of intestinal contents to pass through the tract; mechanical ileus is caused by a physical obstruction (such as a foreign body, intussusception, masses or extrinsic lesions compressing the bowel).

Radiographic signs of mechanical ileus include a variable degree of dilation of bowel loops cranially to the obstruction, with gas and fluid content; longer duration obstructions result in greater intestinal distension and a greater number of distended loops. As more bowel becomes progressively distended, the segments assume a “stacked” appearance. A paper (Sharma, 2010) reported approximately 30 per cent of obstructed dogs did not have radiographic signs of segmental small intestinal dilatation, of which 50 per cent were due to linear foreign bodies.

Sonographically, an ileus appears as distended bowel loops with reduced or absent peristalsis and fluid/gas accumulation. Regional lymphadenopathy may be present due to inflammation.

Acute obstruction of the duodenum is more difficult to see, as the gas and fluid contents tend to accumulate in the stomach.

The value of performing a positive contrast study, radiographic examination in cases of suspected of intestinal obstruction is debatable and, according to some authors, contraindicated. In cases with radiographic and/or sonographic signs of obstruction, minimal additional information may be gained because contrast medium may pass slowly through atonic bowel proximal to the obstruction. Performing a contrast study may also delay surgery. Iodinated contrast medium and barium-impregnated markers are also not indicated in such patients. Patients with radiographic evidence of free peritoneal gas (suggestive of gastrointestinal perforation) are also not appropriate cases for contrast studies.

According to the composition and shape of the foreign body, different sonographic patterns can be
seen. Some types of rubber balls, for example, transmit the sound beam and can be easily identified. A strong acoustic shadow may be created by other kinds of material, but depending on the shape of the object, this may not always be clearly identified as a foreign body.

Linear foreign bodies (such as strings, socks and so on) cause an abnormal shape and contour of the loops. Typically, some portion of the linear object become trapped and this induces an increased peristalsis, which in turn leads the intestinal loops to “climb up”; these loops assume a “plicated” appearance (concertina). This is sometimes seen in radiographs associated with some short tubular or crescent-shaped gas bubbles. The ultrasound appearance of linear foreign bodies is that of a plication (undulating mucosa); sometimes a hyperechoic linear structure is appreciated within the lumen (Hoffman, 2003; Tidwell, 1992).

Intestinal obstruction resulting from an intramural foreign body-associated granuloma has been reported (Papazoglou, 2013), but is not very common.

References

Figure 1 (left). Ultrasound image of an ear bud in a cat’s stomach.
Figure 2 (below). Dog with acute vomiting. Left lateral abdominal radiograph. Gas accumulates in the pylorus. Note fluid/soft tissue opacity with some radiopaque foci in the body of the stomach.
Figure 3 (bottom left). Ultrasound image of the same dog of Figure 2. The stomach is distended with echogenic fluid. An irregularly shaped structure creating shadowing artefact is seen in the lumen.
Figure 4. A piece of towel was found during surgery.
Figures 5a and 5b (left). Radiographs at day 1 and day 2 of an acute vomiting dog. Note the progressive distension of fluid-filled intestinal loops. Can you see a foreign body?
Figures 5a and 5b (left). Radiographs at day 1 and day 2 of an acute vomiting dog. Note the progressive distension of fluid-filled intestinal loops. Can you see a foreign body?
Figure 6 (far left). Ultrasound image of same dog as in figure 5. Can you see the foreign body now?
Figures 7a and 7b (middle and left). Surgical exploration and foreign body removed.
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Figures 8a (above left) and 8b (above right). Ultrasound image of an intestinal linear foreign body and surgical exploration.
Figures 8a (above left) and 8b (above right). Ultrasound image of an intestinal linear foreign body and surgical exploration.