Getting to the guts of it: To radiograph or ultrasound the gastrointestinal tract

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Introduction
When presented with a patient with gastrointestinal disease, especially a vomiting patient, a veterinarian is often faced with the question as to whether the most appropriate test is radiology or sonology. It does depend on the equipment and the sonographic skills available however radiology is often forgotten in the rush to use what is sometimes incorrectly perceived as the better test of ultrasound.

Radiology has many advantages for the investigation of animals with gastrointestinal disease, especially acutely vomiting patients. Abdominal radiology can be performed quickly and easily, without the need for clipping. The radiographs can be obtained and read in around 10 mins, compared with a complete sonographic examination of the gastrointestinal tract (GIT) which may take 45 mins or more. Abdominal radiographs provide an overview of the abdomen, allowing assessment of GIT size, course and contents. A radiopaque foreign body is easily detected and the degree of distension of the stomach and small intestine (SI) may indicate to the veterinarian the presence or absence of mechanical obstruction. In many cases radiology is complementary to sonology and it is often desirable to perform both tests in the one patient. The limitation of radiology however is that radiology is only a “shadow” of the organs and it is not possible to image the internal structure of an organ with radiology. Sonology is a form of cross sectional imaging and therefore enables visualisation of the wall of the GIT and an assessment of the nature of the contents. It must be noted however that in some cases, such as acute and chronic diarrhoea, routine use of abdominal ultrasound for investigation may not be indicated

Radiology
A routine radiographic examination of the abdomen includes a laterally recumbent and a ventrodorsal radiograph (patient in dorsal recency). Please do not take dorsoventral abdominal radiographs (animal in sternal recency). Dorsoventral abdominal radiographs are non-diagnostic due to the inability to stretch the patient in this position and thus separate the abdominal contents; also there is usually superimposition of the hind limbs and often the tail. In any abdominal radiograph it is recommended to stretch the animal to allow separation of the abdominal organs and improved organ visualisation. This also minimises superimposition of the hind limb musculature.

Traditionally is has been said that a radiograph taken in right lateral recency is preferred to left lateral recency. This is because the left kidney is more mobile than the right. When the animal is in right lateral recency the left kidney hangs slightly ventrally allowing better visualisation of each kidney. However it is increasingly recognised that a left laterally recumbent projection is valuable due to the distribution of gas and accumulation of gas in the proximal duodenum. It is recommended that a right laterally recumbent, then left laterally recumbent projection be obtained, then a ventrodorsal, to take advantage of the movement of gas within the stomach and duodenum. Not acquiring both right and left laterally recumbent projections may result in some diagnoses being missed.

The normal SI should be evenly distributed throughout the abdomen however in obese cats the SI can be asymmetrically positioned in the right mid abdomen on a VD radiograph. In the
dog the normal SI may contain a variable amount of gas but should not be uniformly gas filled throughout the duodenum or jejunum. Normal bowel gas is less common in the cat than in the dog. In the fasted cat gas is rarely present in the SI but in fasted dogs 30% to 60% of the SI content may be gas. The normal fluid filled SI is a soft tissue opacity and all loops should be approximately the same diameter.

When assessing a vomiting patient the big question is “does this patient need surgery?” Surgical patients are those with obstruction leading to a mechanical ileus. Mechanical ileus will lead to over distension of the intestinal tract, usually with gas but don’t forget to also assess the fluid filled loops.

When assessing the GIT the position, contents and gas pattern are assessed and then the degree of gastric and intestinal distension. For the stomach on a right lateral recumbent radiograph the normal stomach should be less than three intercostal spaces wide and the fundus approximately two times as wide as the pyloric portion. For the SI the maximum reported normal diameter (serosa to serosa) for a dog (include both gas and fluid filled loops in your assessment) should not exceed 1.6 times the height of the centre of the body of L5, at its narrowest point. This has been further investigated where it was found that using an SI/L5 ratio of 1.7 for diagnosis of intestinal obstruction, the sensitivity and specificity were 66%. The greater the ratio (approaching 2) the more certain you can be of a mechanical obstruction, but you still need to read and interpret the radiograph in light of the patient’s history, clinical examination and the other radiographic findings.

Other rules that have been used historically include: the SI diameter should be to be less than twice the width of a rib- but this over estimates SI distension; or that no loop should be greater than twice the height of the central portion of the body of L4. This has been replaced by the L5 rule.

Because most cats tend to be a similar body size a more specific definition has been determined. In cats the SI should not be greater than 12 mm in diameter, or twice the height of the central portion of L4.

A single dilated SI loop is called a sentinel loop and may indicate obstruction or ileus. This may also be interpreted to mean that no loop should be twice the width of any other. It is really important to assess all loops, the finding of two different degrees of distension within two different groups of intestines should raise suspicions of a mechanical obstruction. Stacked loops is the term used to describe bowel segments (usually distended) that are layered parallel to each other. Stacked loops are usually seen with mechanical ileus. Irregular or tortuous intestinal loops may be seen in partial obstructions by linear foreign bodies or in multiple serosal adhesions.

In the case of the vomiting patient and the question regarding the need for surgery I like to think about cases in three different categories:

1) The clearly normal abdomen- the “green cases”
2) The clearly abnormal abdomen: the surgical cases, these are the “red cases”
3) The ones that are neither clearly normal nor abnormal- these are the “grey cases”

The clearly normal cases require supportive treatment, the clearly abnormal cases need to go straight to surgery. It’s the cases that are neither that are the challenge. The “grey zone” cases are the ones that cause the most anxiety because of the fear that you may be missing something. But, if you have a plan such as below hopefully the anxiety is decreased. Whist there is often anxiety to get these cases straight to ultrasound remember that repeat radiographs in 12-24 hours after a period of supportive treatment is a really useful diagnostic
tool. Radiographs are only a “snap shot” in time and repeat radiographs often provide the answer.

So - this is how I like to think of abdominal radiographs:

The interpretation of the radiographs is informed by the patient’s history, signalment, physical examination and results of any other tests. For cases in the grey zone options include supportive treatment- which may result in an improvement in clinical signs, or if not then repeat radiographs and/or abdominal ultrasound is indicated. In some cases the clinical situation changes so much that an exploratory laparotomy is indicated without further imaging. And of course, for some cases in the grey zone it may be appropriate to proceed from radiographs straight to ultrasound….

**Ultrasonography**

Ultrasound examination of the GIT requires a high level of sonographic skill. Thorough evaluation of the GIT can be very time consuming, but equally very rewarding. It is essential to optimise the image- especially using the “big 4 controls” of depth, gain, TGC and focal zone. Ultrasound examinations should not be performed without educating yourself and reading the following essential textbooks:

- Small Animal Diagnostic Ultrasound 3rd ed
  Nyland TG and Mattoon JS. W. B. Saunders 2015

- Atlas of Small Animal Ultrasonography
  Penninck D and d’Anjou MA
  Blackwell Publishing 2nd ed 2015

For ultrasound examination of the GIT it is important to assess the degree of distension, echogenicity of the contents, the wall layering and thickness, and local lymph nodes.
Normal wall thickness have been described⁷

Dog:
- Duodenum: patient BW:
  - ≤20 kg: ≤5.1 mm
  - 20-29.9 kg: ≤5.3 mm
  - >30 kg: ≤6.0 mm
- Jejunum: patient BW:
  - ≤20 kg: ≤4.1 mm
  - 20-29.9 kg: ≤4.4 mm
  - >30 kg: ≤4.7 mm

Cat:
- Duodenum: 2.0-2.4 mm
- Jejunum: 2.1-2.5 mm
- Ileum: 2.5-3.2 mm

The normal GIT wall consists of layers five layers visible sonographically: the mucosal surface, mucosa, submucosa, muscularis propria, and subserosa/serosa. The hypoechoic mucosal layer is the thickest layer. T (Figure 1). With the introduction of high frequency transducers and no doubt increasing skill level additional layers of SI and regions of echogenicity within the intestinal wall are now recognised. Rectangular depressions may occasionally be seen at the mucosal surface. These are best seen in long-axis. These depressions represent lymphoid follicles (Peyer’s patches) and should not be mistaken for ulcers⁸. They may be seen in dogs with no clinical signs of GIT disease and can be distinguished from true ulceration by the lack of associated wall thickening and loss of layering and the absence of localised fluid accumulation⁸. (Figure 2)

Figure 1: The layers of the small intestine as traditionally described. This is a loop of jejunum. Red arrow: lumen, green arrow: mucosa, purple arrow: submucosa, yellow arrow: muscularis and blue arrow the serosa.
Figure 2 Mucosal depression (yellow arrow), these should not be mistaken for ulcers. Note that in his image the wall layering is normal and the wall is within normal limits for thickness. This makes true ulceration unlikely.

Occasionally a region of hyperechogenicity extending into the hypoechoic mucosa is seen on either side of the lumen. This probably represents altered alignment of villi in collapsed bowel segments. (Figure 3)

Figure 3: Jejunum with a number of regions of hyperechogenicity (yellow arrows) extending into the hypoechoic mucosa.
The inner wall of the normally hypoechoc mucosal layer may be mildly hyperechoic, this is considered to be a normal variation and is likely due to fluid, gas and small particles between the villi\textsuperscript{10}. (Figure 4) If this hyperechogenicity is very bright it may indicate mild to moderate dilation of lacteals\textsuperscript{10} (Figure 5). A small number of focal or multifocal hyperechoic striations may be seen in the mucosa of the small intestines of dogs due to mild lacteal dilation\textsuperscript{11,12}. (Figure 6) Patchy, multifocal striations within the mucosa may be seen immediately after eating, this is likely due to an artefact of reflections or mucus contents or the admixture of food at the mucosal surface in the lumen\textsuperscript{12}.

Figure 4: Faintly hyperechoic inner mucosal layer (red arrow), a normal variation due to fluid, gas and small particles between the villi.

Figure 5: A bright hyperechogenicity within the mucosal layer due to moderate dilation of lacteals.
Occasionally an echogenic line is seen within the mucosa adjacent to the submucosal margin. This is reported to be due to enlarged lymphoid follicles extending from the submucosa into the lamina propria of the mucosal layer\textsuperscript{10}. (Figure 7) This may be seen in cats as an asymmetric hyperechoic line within the mucosa\textsuperscript{13}. A thin hyperechoic line within the muscularis layer is due to due to a small amount of fibrous tissue between the inner circular and outer longitudinal layers of the muscularis layer\textsuperscript{10}.

Figure 6: A small number of focal or multifocal hyperechoic striations may be seen in the mucosa of the small intestines of dogs due to mild lacteal dilation.

Figure 7: Echogenic line (red arrow) within the mucosa in a dog. The hypoechoic line (yellow arrow) represents the enlarged lymphoid follicles extending into the mucosa from the submucosa. The hyperechoic line is due to the reflection of sound from the interface of the enlarged lymphoid follicles and the mucosa.
Alteration to the layering of the GIT is typically seen in neoplasia. It has been reported that dogs with loss of layering in the intestines are 50.9 times more likely to have neoplasia than inflammatory bowel disease\(^2\). Sonographic examination allows determination of the extent of the disease, involvement of local lymph nodes and assess for the presence of metastases. Although loss of layering is commonly seen in gastrointestinal neoplasia many cases of lymphoma may be seen as thickening of the muscularis layer with maintenance of normal layering\(^{14,15}\). In these cases sonographic differentiation of neoplasia from IDB is not possible and full thickness biopsies are required for the definitive diagnosis. There is an increasing recognition of the findings of normal layering in cases of lymphoma, particularly cases of lymphocytic lymphoma\(^{16}\). These cases require full thickness biopsies for confirmation of the presence of lymphoma. In cases where a mass lesion is present fine needle aspiration is usually rewarding as a common neoplastic lesion- lymphoma exfoliates well on aspiration.

Features that may help to differentiate small intestinal neoplasia from non-neoplastic conditions:
- enteritis generally produces diffuse, concentric wall thickening, which is often only 1–2 mm thicker than normal\(^{17}\)
- wall layering is normally preserved in enteritis, although the layers may be blurred\(^{17}\)
- wall layering is usually altered in neoplastic conditions, although certain lymphoma are an exception to this rule

SI foreign bodies are usually seen as hyperechogenicities with marked distal acoustic shadowing. It is important to image these structures in multiple planes to fully evaluate the shape. Corn cobs typically give rise to an irregularly hyperechoic surface with marked distal acoustic shadowing and a cylindrical shape. SI distension surrounding the foreign body is typically seen. A serosal to serosal measurement of jejunal diameter of greater than 1.5 cm is suggestive of a mechanical obstruction\(^{18}\). The finding of jejunal loop greater than 1.5 cm in diameter should prompt a thorough search of the abdomen for an obstructive lesion\(^{18}\).
Conclusion
This is a brief overview of GIT imaging with radiology and ultrasound. Remember- if you have a case in the ‘grey zone” don’t panic but have a plan for supportive treatment, plus/minus ultrasound examination or follow up imaging such as repeat radiographs or ultrasound in 12-24 hours. Radiology and ultrasonography are often complementary tests.

References


