Received: 28 November 2021 | Revised: 26 February 2022 | Accepted: 14 March 2022

DOI: 10.1002/vrc2.357

Vet Record CaseReports

CASE REPORT

Companion or pet animals

Diagnostic imaging appearance of canine gastric leiomyomas: Four cases

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This work was presented at the ECVDI Congress in Basel 2019.

[Correction added on 20 May 2022, after first online publication: The copyright line was changed.]

Abstract

Gastric leiomyoma is an uncommon benign neoplasm found in older dogs and generally identified as an incidental finding. The purpose of this manuscript is to describe the imaging appearance of gastric leiomyoma in different diagnostic imaging modalities (radiography, ultrasonography and computed tomography). All three modalities revealed a mass arising within the gastric wall, radiopaque on radiography, hypoechoic on ultrasonography and isoattenuating on computed tomography, with intralesional radiopaque/hyperechoic/hyperattenuating foci, respectively. Ultrasonography and computed tomography are sensitive and proved very useful in the diagnosis of this type of neoplasia, identifying the location, extent and appearance of the mass before a surgical treatment. Gastric leiomyoma should be considered as a possible diagnosis in the presence of dystrophic mineralisation within a gastric mass.

KEYWORDS
dogs, imaging, stomach, tumours

BACKGROUND

Gastrointestinal (GI) neoplasms are rare in small animals, with an incidence of less than 1%.[1] Leiomyoma is the most common benign tumour of the GI tract, originating from the smooth muscle.[1] In dogs, leiomyomas have been reported in other locations apart from the gastrointestinal tract, including the oesophagus,[2] respiratory,[3] reproductive[4] and urinary tracts.[5]

Gastric leiomyoma (GL) is a benign mesenchymal neoplasm of muscular origin generally eccentrically placed in the gastric wall and characterised by its slow growth. Due to its origin, the mucosa usually remains intact and, therefore, gastric ulceration and haemorrhage are rare.[6] GL tend to affect older patients[7] and although they can be located anywhere in the stomach, the most common location is the cardia or the gastro-oesophageal junction, accounting for 94% of cases.[6] They are mostly found incidentally and are usually asymptomatic, only causing clinical signs due to their size and location.[6,8–10] The prognosis is good after surgical removal of the mass when a complete excision is achieved.[6,10]

Several reviews of gastrointestinal neoplasia have been reported previously in veterinary medicine.[1,7–15] However, to the authors' best knowledge, there is no specific information regarding the different imaging modalities for GL in dogs. The authors suggest that early detection and differentiation of this type of neoplasia might help to provide the best treatment and prognosis for these patients. The purpose of this retrospective case series was to describe the diagnostic imaging appearance of GL on (XR), ultrasound (US) and computed tomography (CT), and compare these findings to the human[16–18] and veterinary literature.

CASE PRESENTATION

Case records from a referral hospital were retrospectively reviewed from 2017 to 2019. All dogs with suspected gastric masses that had XR and US were assessed, but only cases with imaging and histopathological diagnosis of GL were included. Four cases met the inclusion criteria. For each case, a complete history, clinical examination and imaging findings (XR, US and CT when available) were evaluated (Table 1).

Radiographs were performed using digital direct radiology equipment (X-ray beam limiting device BLR-1000A, Canon Medical System, Tokyo, Japan) in all the cases of the gastric silhouette. The following settings used were: 55 kV, 16 mAs for thoracic radiographs; and 75 kV, 8 mAs for abdominal radiographs. At least two orthogonal views were performed in each patient. Radiographs were evaluated for the following criteria: identification of a gastric mass (yes/no), presence of mineralisation (yes/no) and other radiographic findings.

Complete abdominal US (Aplio 300; Toshiba Medical Systems Corporation, Tokyo, Japan) was performed by an ECVDI-certified veterinary radiologist (R. Salgüero) under sedation. Patients were positioned in lateral recumbency and

ultrasonographic images were obtained using a microconvex transducer with a frequency range 5–7 MHz. Imaging findings recorded included identification of the mass, localisation within the stomach, maximum diameter size (thickness taken from the inner mucosal interface to the outer aspect of the serosa) and echogenicity, appearance of the borders (smooth or irregular), identification of the layer of origin, presence of mineralisation (yes/no), presence of lymph node enlargement and other ultrasonographic findings such as presence of abdominal effusion, evidence of ulceration or perforation in the gastric wall, metastasis and similar lesions in other organs.

CT (Aquilion Lightning, Toshiba Medical System Corporation, Tokyo, Japan; 16-row multi-detector helical CT) was performed under general anaesthesia in Cases 2 and 4. Patients were positioned in sternal recumbency. In both cases, the following machine settings were used: 120 kV, 50–100 mA, helical mode, 512 × 512, pitch of 1, slice thickness of 1–2 mm and 0.75 s tube rotation time. Soft tissue (low-frequency algorithm) and lung (high-frequency algorithm) acquisitions were obtained. After the pre-contrast scan, intravenous (IV) iodinated non-ionic contrast medium (300 mg iodine/ml IV ioversol, Optiray, Guerbet, France) at 2 ml/kg was administered manually in a cephalic vein, and two post-contrast (immediate and approximately 40 seconds after administration) examinations were performed.

Thoracic images were evaluated in lung (WL 550, WW 1600) and soft tissue (WL 50, WW 350) windows and abdominal images, in soft tissue (WL 50, WW 350) and bone (WL 300, WW 1500) windows, using a DICOM Medical Image Viewer (Horos version 3.0.0 Horosproject.com) by a ECVDI-certified veterinary radiologist (R. Salgüero). The CT images were assessed for: presence of a gastric mass (yes/no), size, localisation in the stomach, identification of a muscular origin, attenuation values (Hounsfield units [HU]), contrast enhancement (homogeneous/heterogeneous), areas of intralesional mineralisation (yes/no) and other abnormalities. There was no evidence of abdominal lymph node enlargement in any of the cases.

Case 1

A 15-year-old, 7.9 kg, female neutered (FN), West Highland white terrier (WHWT) was presented with a history of exercise intolerance, anorexia, vomiting and loose stools. Abdominal XR revealed an ill-defined, soft tissue mass in the gastric fundus with small radiopaque intralesional foci compatible with mineralisation. Other radiographic findings included moderate dilation of the intestinal loops with gas content. Abdominal US revealed a focal, well-demarcated, heterogeneous but mainly hypoechoic mass with eccentric growth and without evidence of cavitation (Figure 2a). There was a loss of the normal layered echo-structure of the gastric wall in the area of the mass. The mass was located in the fundus, round in shape with slightly irregular surface and measured 2.6 × 2.7 cm in size. There were also hyperechoic areas compatible with intralesional mineralisation. Furthermore, a right hyperechoic adrenal mass (3.3 × 2.7 cm) was found without vascular invasion as well as degenerative renal changes.

LEARNING POINTS/TAKE HOME MESSAGES

- The presence of gastric leiomyoma should be suspected when a small, focal, hypoechoic and partially mineralised gastric mass originating from the muscular layer is seen in radiography or ultrasound in small-breed dogs.
- Computed tomography is a useful imaging modality to locate the gastric neoplasia, evaluate the extension and appearance before possible surgical treatment, to provide an overview of the patient and evaluate the presence of other lesions.
- Leiomyoma should be considered as a possible diagnosis in the presence of dystrophic mineralisation within a gastric mass.

Case 2

A 13-year-old, 9.2 kg, FN, WHWT was presented for vomiting. Abdominal and thoracic XR revealed an ill-defined, soft tissue mass in the pyloric antrum, with small radiopaque intralesional mineralisation (Figure 1) and hepatomegaly. US revealed a focal, well-demarcated, heterogeneous but mainly hypoechoic mass with eccentric growth and an absence of

TABLE 1 The main findings regarding the imaging techniques of each case

		Case 1	Case 2	Case 3	Case 4
XR	Identification of the mass	Yes	Yes	No	Yes
	Presence of mineralisation	Yes	Yes	No	Yes
US	Size	2.6 × 2.7 cm	3.2 × 2 cm	2.5 × 2.1 cm	2.3 × 1 cm
	Location within the stomach	Fundus	Pylorus	Cardias	Cardias
	Identification of muscular origin	Yes	Yes	No	Yes
	Presence of mineralisation	Yes	Yes	No	Yes
CT	Performed	No	Yes	No	Yes
	Size	–	3.4 × 2.7 cm	–	2.5 × 1.5 cm
	Location within the stomach	–	Pylorus	–	Cardias
	Identification of muscular origin	–	Yes	–	Yes
	Contrast enhancement	–	Homogeneous	–	Homogeneous
	Areas of intralesional mineralisation	–	Yes	–	Yes

Abbreviations: CT, computed tomography; US, ultrasound; XR, radiography.

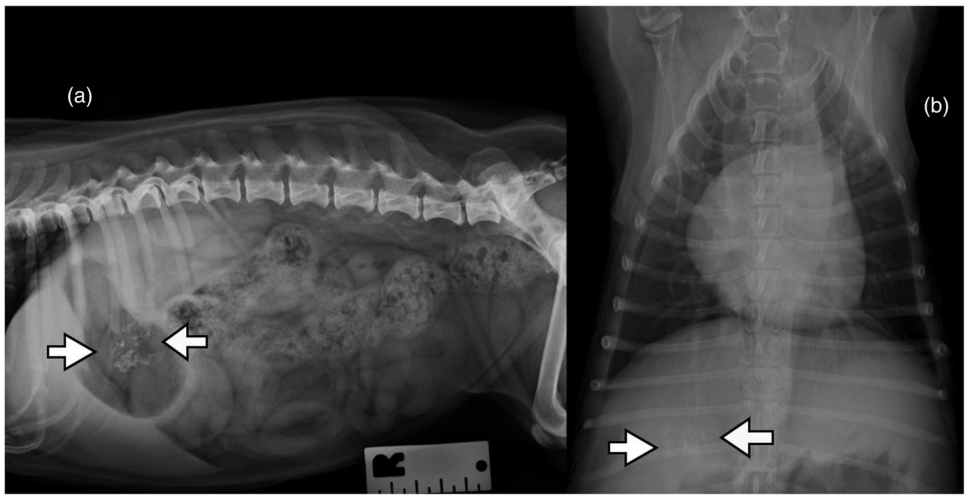

FIGURE 1 Right lateral abdominal radiograph (a) and dorsoventral thoracic radiograph (b) of the same dog (Case 2), showing an ill-defined soft tissue lesion in the area of the pyloric antrum with ill-defined intralesional mineralisation (arrows)

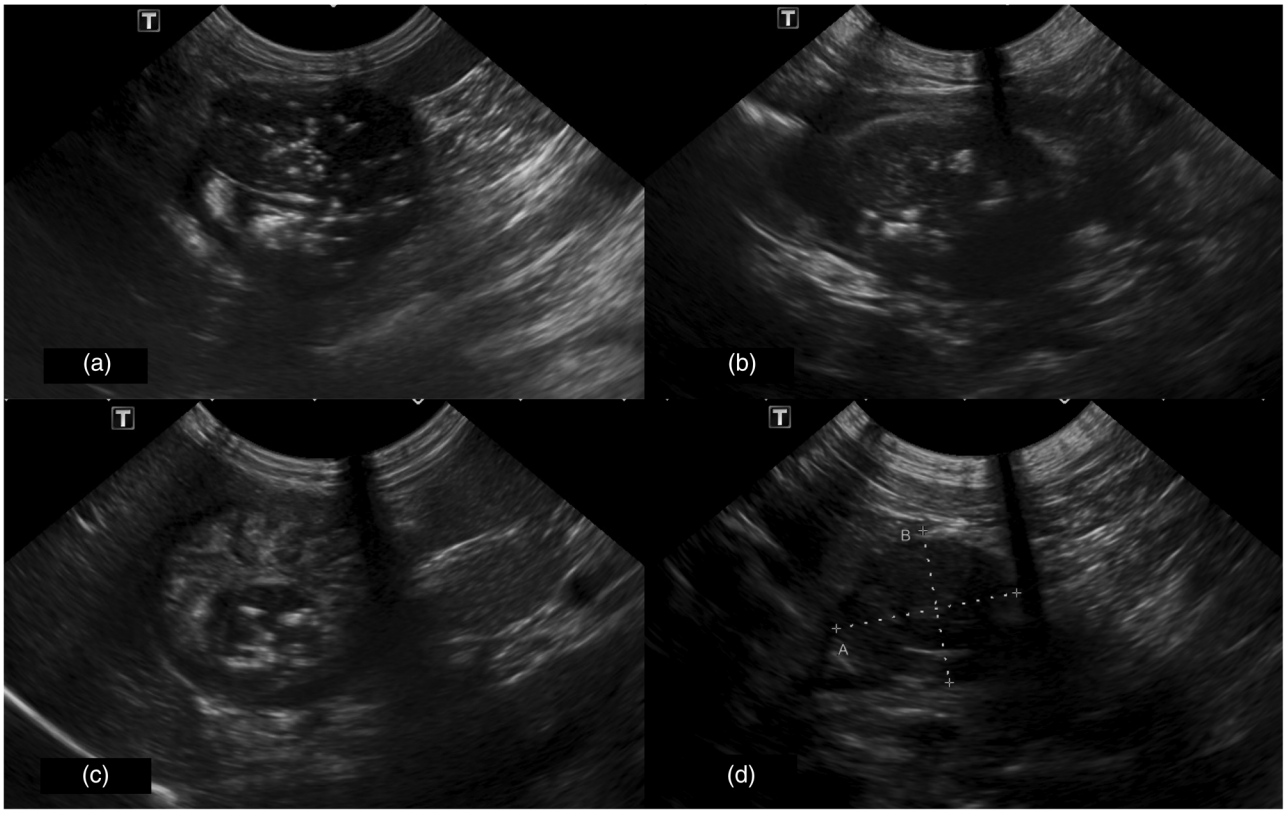

FIGURE 2 Ultrasound images on B-mode of the four cases. A heterogeneous but mainly hypoechoic masses are present with hyperechoic mineralisation in Case 1 (a), Case 2 (b) and Case 4 (c) images. And a similar mass without cavitation or mineralisation in Case 3 (d)

cavitation, arising from the muscular layer. The mass was located in the pylorus and measured 3.6 × 2.0 cm in size. It was round in shape with smooth margins and the presence of hyperechoic foci compatible with mineralisation (Figure 2b). Hepatomegaly, small, poorly defined splenic lesions and mild enlargement of the caudal pole of the right adrenal (7.6 mm) were also noted. Thoracic and abdominal CT were performed where a focal and well-defined pyloric mass was found, identifying an intact mucosal layer superficial to the mass. The mass measured 3.4 × 2.7 cm in size, was isoattenuating to the muscular layer of the gastric wall (45 HU) with hyperattenuating foci compatible with mineralisation, giving some heterogeneity to the lesion and showing mild-to-intermediate homogeneous contrast enhancement (125 HU), excluding the areas of mineralisation (Figure 3a,b). Other CT abnormalities found included moderate diffuse bronco-interstitial lung pattern, generalised cardiomegaly, mild hepatomegaly, adrenal asymmetry and mild degenerative disease affecting the spine.

Case 3

A 20-year-old, 5.5 kg, FN terrier crossbreed dog was presented for chronic diarrhoea. Abdominal XR did not show

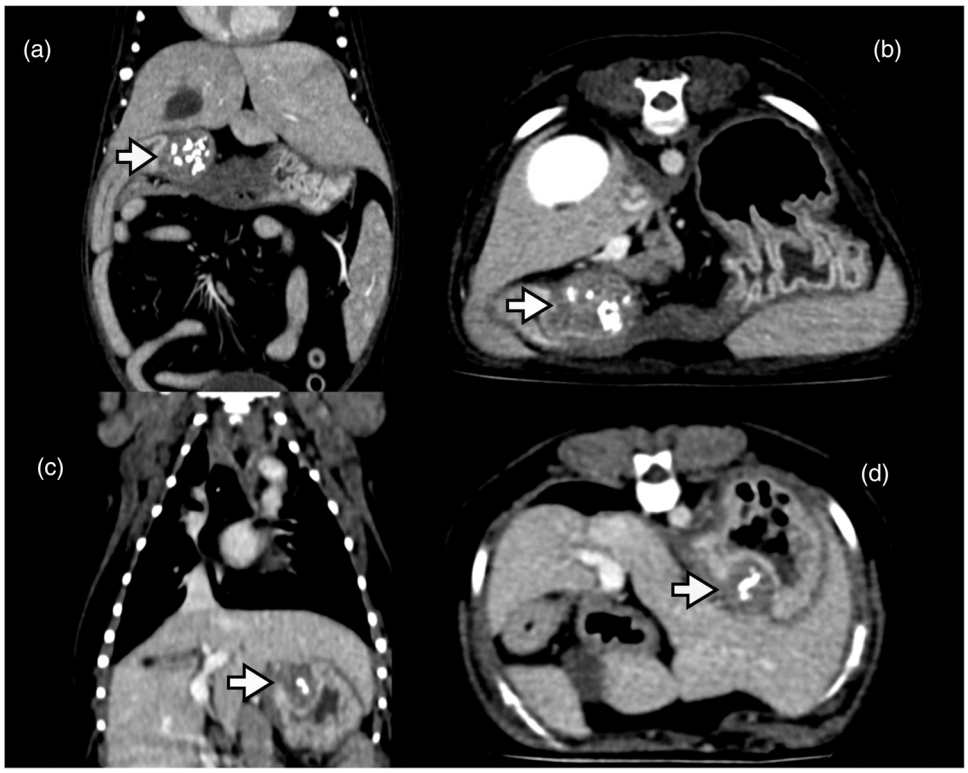

FIGURE 3 Dorsal and transverse computed tomography images of Cases 2 and 4. A focal and well-defined gastric mass is seen, one in the pyloric area in Case 2 (a and b) and in the cardia in Case 4 (c and d). The masses were isoattenuating to the muscular layer with intralesional mineralisation (arrows)

a gastric mass, as in the other cases, nor other abnormalities. US revealed a focal, well-demarcated, heterogeneous but mainly hypoechoic gastric mass, without evidence of cavitation, close to the cardia (Figure 2d). The lesion had eccentric growth, revealing loss of the normal layered echo-structure, with no possible identification of a muscular origin, this was only reported in the histopathological analysis. The mass measured 2.5 × 2.1 cm in size and was round with slightly irregular surface. An absent spleen due to a previous surgery, chronic degenerative renal changes and a left adrenal mass (3.0 × 3.0 cm in size) were other abnormalities found in the US examination.

Case 4

Case 4 was a 10-year-old, 4 kg, FN, Yorkshire terrier with no clinical signs. The imaging study was performed as part of metastatic staging for a mammary tumour, and the presence of a GL was found incidentally. Thoracic XR revealed an ill-defined, soft tissue mass in the cranial abdomen, at the level of the cardia, with small radiopaque intralesional areas compatible with mineralisation. Thoracic radiographs showed mild tracheal collapse and cardiomegaly. US revealed a focal, well-demarcated, heterogeneous but mainly hypoechoic mass with eccentric growth close to the cardia (Figure 2c). It showed loss of the normal layering, and a muscular origin was identified. The mass measured 2.3 × 1.0 cm in size, was elongated in shape with smooth margins and hyperechoic foci, compatible with mineralisation. A thoracic CT including the stomach was performed. A focal and well-defined gastric mass was found, identifying a possible muscular origin and showing an intact mucosa layer. The mass was confirmed to be localised in the cardia, was 2.5 × 1.5 cm in size, isoattenuating to the muscular layer of the gastric wall (54 HU) with hyperattenuating foci compatible with mineralisation, which gave some heterogeneity to the lesion (Figure 3c,d). It showed mild-to-intermediate homogeneous contrast enhancement (92 HU), excluding the areas of mineralisation. Additional CT findings included marked diffuse bronco-interstitial lung pattern and right-sided cardiomegaly.

DIFFERENTIAL DIAGNOSIS

The imaging findings were very similar in the four cases included, with the most likely differential diagnosis being the presence of a GL. However, other possibilities such as inflammatory polyp or adenoma, a neoplastic process including leiomyosarcoma, gastrointestinal stromal tumour or carcinoma, could not be completely ruled out.

TREATMENT

The four cases presented with the suspicion of GL had an exploratory laparotomy under general anaesthesia, and a focal gastrectomy was performed to remove the mass. All recovered uneventfully from the anaesthesia and were discharged from the hospital 2–3 days after the surgery.

OUTCOME AND FOLLOW-UP

Histopathology of the gastric mass was performed in all the cases, which confirmed a muscular origin. The samples were moderately cellular, containing oval and elongated cells with a

low mitotic index and minimal anisokaryosis and anisocytosis, indicating histological signs of low malignancy in all cases. Apart from these similarities, Cases 1, 2 and 4 showed a mild infiltration with lymphocytes and plasma cells, as well as mild oedema of the gastric wall. Furthermore, in Case 2, cavitated central areas containing material with minimal surrounding necrosis were observed. The final diagnosis in all of the cases was GL.

One year after the surgery, two cases had no recurrence of the clinical signs or regrowth of the mass, and the other two cases were lost to follow-up.

DISCUSSION

Gastric neoplasms are not common in dogs, with adenocarcinoma, lymphoma and leiomyosarcoma being the most frequent malignant tumours.[8,19] The most common benign gastric tumours are leiomyoma and adenoma.[15,20]

The clinical signs in cases of GL include vomiting, regurgitation, anorexia, weight loss, diarrhoea, weakness and collapse.[6,8–10] However, GL do not generally show clinical signs due to their small size, unless they are located in the area of the cardia or pylorus, where they can cause partial or complete obstruction of the alimentary tract. The signs described in our cases are similar to those reported previously for GL, where some of the patients had gastrointestinal (vomiting, loose stools or diarrhoea) or non-specific signs such as exercise intolerance and anorexia. In Cases 3 and 4, the GL were found incidentally, as is usually the case in human patients where they are often discovered on routine upper gastrointestinal endoscopy.[16,17]

Regarding the age of presentation, patients have been reported to be as old as in our cases, where the mean age was close to 15 years.[12] No previous evidence of breed or sex predisposition was found.[1,4,6,8,16,21] However, all the cases presented here were small-breed terriers and, although a conclusive breed-specific tumour incidence cannot be made in this study, this should be taken into account for future research on this type of gastric neoplasia.

The low number of cases of GL in the veterinary literature may be due to its asymptomatic nature or non-specific clinical presentation, as apparent in most of our cases, which makes its detection and diagnosis difficult. The authors found that GL can be difficult to detect on radiographs due to their small size and in US, as it is highly dependent on the operator's technique and can be challenging in those cases where the mass is located in the cardia or gastroesophageal junction due to the location and the presence of gastric contents.[1] The presence of mineralisation in the region of the stomach on routine XR in older dogs should make veterinarians suspicious of the presence of GL.

Despite the fact that the most common location of GL in veterinary and human medicine is reported to be the gastroesophageal junction[6] and cardia,[12,18,21] our case series showed only 50% of the cases in the cardia, with the other two located in the fundus and pylorus, respectively. This is possibly due to the low number of cases presented, which was not representative, or because locating this type of lesion in the pylorus and fundus is easier than in cardia, and that cases affecting the cardia are underestimated. Nevertheless, in a recent study of gastric tumours, 50% of the GL were located in the cardia, with 25% in the fundus and 25% in the body of the stomach.[15]

Contrast radiography can be used instead of plain radiography to evaluate the stomach, because gastric wall thickness can only be accurately evaluated in radiology when the stomach is distended by gas or when radiopaque contrast medium is administrated, and a filling defect is detected. Also, there are no specific radiographic features that can help to distinguish between different neoplasms, the radiographic identification of the lesion depends on the size, shape and location of the tumour.[19] Due to the low sensitivity of plain radiology, US is generally used to evaluate the GI tract in veterinary patients.[1,12,20] US was 100% sensitive in our cases, compared to 75% of the cases identified on plain radiographs thanks to the presence of intralesional mineralisation. However, in another study, US did not locate three-fourth of the GL, which were subsequently detected by CT.[15] In our case, due to the retrospective nature of the study, some of the cases of GL might have remained undiagnosed in the absence of clinical signs or investigations.

Several ultrasonographic features of GI mesenchymal tumours have been described, with intramural, smooth muscle tumours growing out of the muscular layer as eccentric masses.[1] Differentiation between leiomyomas and leiomyosarcomas has been proposed, with leiomyosarcomas being larger, eccentric and of mixed echogenicity in comparison to leiomyomas, which are smaller in size (<3 cm), with no evidence of intralesional cavitations/ulcerations, neither were associated with signs of lymphadenopathy or peritoneal effusion.[1,9] This is similar to what was found in our series, as the masses were small, less than 4 cm in all of them and homogeneous, with the exception of the small mineralisations present. Absence of lymphadenopathy may increase the likelihood of a benign lesion. However, Zuercher et al. described the presence of lymphadenopathy in two of the four cases of GL.[15]

There are no ultrasonographic features that reliably allow differentiation of smooth muscle tumours from gastrointestinal stromal tumours (GISTs). Even though location by itself cannot discriminate the nature of the tumour, it might be helpful as GISTs have a higher incidence for caecal location, whereas leiomyomas commonly affect the stomach,[1,6,9,14] as in our cases. When gastric in origin, GISTs tend to project into the GI lumen.[1,6,9,14] Simeoni et al. in a recent study, comparing B-mode and contrast-enhanced ultrasonography, did not find specific features to discriminate between the different gastric tumours.[22]

Regarding the appearance of GL on CT, there are similarities with human patients and other veterinary reports, where GLs are well-defined lesions, isoattenuating and homogeneous (dogs: 51 ± 3 HU; humans: 69.4 ± 12 HU) with low-to-intermediate post-contrast enhancement, similar to that seen in the cases presented here, taken from the nonmineralised areas in our patients.[15] Tanaka et al. in 2019 reported the presence of two GL, which showed heterogeneous enhancement, due to what they believed was the presence of mineralisation.[21] On the other hand, Zuercher et al. presented half of the GL lesions with heterogeneous enhancement and the other half with homogeneous enhancement.[15] In comparison to them, our study reveals a homogeneous contrast pattern, similar to the human cases.[17,18] Additionally, Kyung et al. described that the enhancement pattern and attenuation value could help

differentiating leiomyomas from GISTs in the gastric cardia in human patients.[18] Furthermore, wall layering enhancement of the mucosal surface could happen on the late post-contrast CT examination, allowing differentiation between layers in the gastric wall.[23] In the authors' opinion, these findings could be helpful to discriminate the muscular origin of a gastric tumour. Despite the differences described to help narrow the list of differential diagnoses, histology is still necessary for a final diagnosis.[21]

The definitive diagnosis in the cases presented were based on excisional biopsies obtained at surgery, but in three of the cases, US-guided fine-needle aspirations (FNA) were performed, but it proved impossible to obtain useful material for a cytological study. US-guided FNA of the gastrointestinal lesions can be an accurate and safe minimally invasive procedure to obtain a definite diagnosis in some cases. However, FNA of malignant lesions have a higher percentage of correct diagnoses than benign ones.[24]

When we compare the characteristics in the different imaging modalities between the cases of GL published in veterinary[1,6–9,12–15,20,21] and human medicine[16,18] and also with the cases of our study, we can appreciate that there are many similarities between them. All GL are masses growing from the muscular layer, most of them localised in the area of the cardia. Only one recent veterinary report has shown that one of four of their cases with GL had changes compatible with intralesional macroscopic mineralisation in US and CT.[15] However, there are several human publications where mineralisation of GL has also been reported in US and CT,[16,18] as shown in our cases. Furthermore, in our study, three quarters of the masses were calcified to an extent where they were also visualised on radiography. In human medicine, the prevalence of mineralisation on US is 14%[16] and 12% on CT imaging.[18]

We must bear in mind that two of our dogs had adrenal nodules or unilateral adrenomegaly, and although they did not have clinical signs of hyperadrenocorticism, one must consider that dystrophic mineralisation of the gastric wall has been described in some cases of hyperadrenocorticism.[25] However, additional prospective clinical studies performed with histopathologic correlation are recommended to further evaluate the validity of this feature.

One of the limitations of this study is the small study population size; therefore, further studies with larger number of cases of GL are required to determine the specific features of GL and to determine if the presence of mineralisation could be an important imaging characteristic.

FUNDING INFORMATION

The authors received no specific funding for this work.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

ETHICS STATEMENT

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. No ethical approval was required as this is a review article with no original research data.

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How to cite this article: Segarra A, Herrtage ME, Salgüero R. Diagnostic imaging appearance of canine gastric leiomyomas: Four cases. Vet Rec Case Rep. 2022;e357. https://doi.org/10.1002/vrc2.357

MULTIPLE CHOICE QUESTION

Which is not a true statement about gastric leiomyomas?

POSSIBLE ANSWERS TO MULTIPLE CHOICE QUESTION

A. Gastric leiomyomas (GL) are neoplasms growing from the muscular layer, and due to its origin, the mucosa usually remains intact and, therefore, gastric ulceration and haemorrhage are rare.
B. GL are benign neoplasm found in older dogs. Being the most common benign gastric tumours leiomyoma and adenoma.
C. GL should not be considered as a possible diagnosis in the presence of dystrophic mineralisation within a gastric mass.
D. Computed tomography is useful to locate GL, determine the extension and appearance before possible surgical treatment.
E. The presence of GL should be suspected when a small, focal, hypoechoic and partially mineralised gastric mass is seen in US in small-breed dogs.
F. There are no specific radiographic features that can help to distinguish GL from other types of neoplasms; histology is necessary for a final diagnosis.

CORRECT ANSWER

C. GL should be considered as a possible diagnosis in the presence of dystrophic mineralisation within a gastric mass. As in most of the cases presented here, one recent veterinary report and several human publications, the presence of mineralisation in cases of GL had been reported.