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Computed tomography diagnosis of intermittent type IV paraoesophageal hernia in a dog

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**COMPUTED TOMOGRAPHY DIAGNOSIS OF INTERMITTENT
TYPE IV PARAOESOPHAGEAL HERNIA IN A DOG.**

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Topics:	Radiology, Surgery, Imaging
Abstract:	In hiatal hernia, elements of the abdominal cavity herniate through the oesophageal hiatus into the mediastinum. Although they are uncommon in both human and veterinary medicine, patients can develop significant clinical complications such as severe gastrointestinal signs, gastric dilatation and volvulus syndrome and, in some cases, death. The most comprehensive classification scheme recognises four types of hiatal hernia. Herein, we describe a first report of a dog with subclinical intermittent type IV paraoesophageal hernia. Computed tomography assisted a rapid, definitive diagnosis and illustrated both the dynamic nature of this type of hernia and the potential for it to lead to severe respiratory compromise. It also facilitated rapid, surgical planning, increasing the likelihood of a successful surgical outcome.

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TITLE OF CASE <i>Do not include "a case report"</i>
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COMPUTED TOMOGRAPHY DIAGNOSIS OF INTERMITTENT TYPE IV PARAOESOPHAGEAL HERNIA IN A DOG.
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SUMMARY <i>Up to 150 words summarising the case presentation and outcome (this will be freely available online)</i>
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In hiatal hernia, elements of the abdominal cavity herniate through the oesophageal hiatus into the mediastinum. Although they are uncommon in both human and veterinary medicine, patients can develop significant clinical complications such as severe gastrointestinal signs, gastric dilatation and volvulus syndrome and, in some cases, death. The most comprehensive classification scheme recognises four types of hiatal hernia. Herein, we describe a first report of a dog with subclinical intermittent type IV paraoesophageal hernia. Computed tomography assisted a rapid, definitive diagnosis and illustrated both the dynamic nature of this type of hernia and the potential for it to lead to severe respiratory compromise. It also facilitated rapid, surgical planning, increasing the likelihood of a successful surgical outcome.

BACKGROUND *Why you think this case is important – why did you write it up?*

This is the first report of subclinical intermittent type IV paraoesophageal hernia diagnosed using CT. CT provided a definitive diagnosis prior to surgery and demonstrated the highly mobile character of the disease. CT-aided rapid surgical planning and management, potentially contributed to a successful outcome in this patient.

CASE PRESENTATION *Presenting features, clinical and environmental history*

A 1-year 1-month-old, male, French bulldog was presented to our institution's Cardiopulmonary Service for investigation of a heart murmur. There was no history of exercise intolerance or signs consistent with gastrointestinal disease.

On physical examination, there was a left-sided systolic grade III/VI murmur, loudest at the heart base, and a right-sided systolic grade III/VI murmur over the cardiac apex. Otherwise, physical examination was unremarkable.

INVESTIGATIONS *If relevant*

Routine haematology and serum biochemistry were unremarkable. Echocardiography revealed severe type 1 pulmonic stenosis, with moderate pulmonic insufficiency.

Pulmonic balloon valvuloplasty was planned but additional imaging was scheduled to rule out a right 2A (R2A) aberrant coronary artery that would preclude this intervention (1). The femoral arteries in the patient were subjectively very small, so instead of selective coronary angiography, an ECG-gated cardiac computed tomography (CT) was performed using a third-generation helical CT unit (Siemens SOMATOM Definition AS, Siemens AG, Munich, Germany) under general anaesthesia (GA). Pre-contrast images of the thorax were acquired uneventfully and did not reveal any abnormalities in the caudal mediastinum or pleural space. Only mild gas distention of the thoracic oesophagus was present (FIG. 1 Panel A). Following the administration of contrast medium (Niopam™ 340 at a 700mg iodine/kg dose) and during image acquisition, the patient became acutely tachypnoeic, with a restrictive breathing pattern. Under the GA the subclinical condition became clinically apparent. In the contrast-enhanced series (acquired 6 minutes after the first scan) the stomach, spleen and dorsal portion of the left lateral liver lobe had herniated into the paraoesophageal space, and were causing a moderate mass effect on the heart and lungs, displacing them ventrally (FIG.

1 Panel B). The patient was immediately repositioned by elevating the head and thorax with a CT-compatible wedge, and a third series of images was acquired. This scan was extended to include the cranial abdomen. The stomach, spleen and liver had returned to their normal anatomical position, and the oesophagus was now filled with a moderate amount of homogeneous fluid (FIG. 1 Panel C). A diagnosis of intermittent type IV paraoesophageal hernia was made. No coronary artery abnormalities were identified.

DIFFERENTIAL DIAGNOSIS *If relevant*

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TREATMENT *If relevant*

Given the extent of abdominal organ displacement and the severity of respiratory compromise it induced, the valvuloplasty procedure was postponed and consent for surgical correction of the diaphragmatic hernia obtained. A routine midline exploratory laparotomy was performed. Mild contusions of the serosa/muscularis layers at the mid-body of the stomach were consistent with recent incarceration within the thorax. A stretched and flaccid phrenico-oesophageal ligament was also identified. The diameter of the oesophageal hiatus was reduced using simple interrupted 3 metric polydioxanone sutures placed through the diaphragm, avoiding excessive constriction of the terminal oesophagus by first advancing an antegrade orogastric tube into the lumen as a guide. An incisional left-sided gastropexy was also performed. Recovery from surgery was uneventful, and the patient was discharged the following day.

OUTCOME AND FOLLOW-UP

Two months after the surgical repair of the hernia, the patient was presented for balloon valvuloplasty. Pulmonic valvuloplasty was performed uneventfully. At the latest follow-up appointment (3 months after initial diagnosis) the patient was exercising normally and remained free from clinical signs.

DISCUSSION *Include a very brief review of similar published cases*

This is the first case report to describe definitive diagnosis of Type IV hiatal hernia in the dog, based on CT images. Hiatal hernia refers to laxity of the oesophageal hiatus that can allow abdominal viscera to displace into the mediastinum or pleural space (2). The most comprehensive classification scheme adapted for veterinary medicine recognises 4 types of hiatal hernias (3). In Type I (sliding hiatal hernia), the most common form, there is a widening of the muscular hiatal tunnel and circumferential laxity of the phreno-oesophageal membrane, allowing a portion of the gastric cardia to herniate cranially. Types II, III and IV all have a para-oesophageal component, but in Type IV, there is a large defect in the phreno-oesophageal membrane that allows other organs, such as colon, spleen, pancreas and small intestine to enter the hernial sac (3) (Fig.2).

In all of the previous veterinary case reports of Type IV hiatal hernia (4-7), the pre-operative

1 diagnosis was presumptive, based on plain and contrast radiographic examinations, and only
2 confirmed during surgery. Establishing which organs have herniated and the classification of
3 hernia on radiography is challenging. In this case, CT provided high resolution images
4 without the superimposition of abdominal structures, that permitted a definitive diagnosis to
5 be made immediately and without the need for a barium study that carries risks of aspiration
6 pneumonia (8). This had direct clinical benefit in 2 ways. First, the temporal association
7 between the displacement of the abdominal organs and the development of respiratory
8 compromise permitted immediate, repositioning of the dog in an attempt to facilitate return
9 of the herniated viscera into the abdomen and improve respiratory function. Indeed, the
10 success of such a manoeuvre has only been previously described anecdotally in cases of
11 diaphragmatic rupture. Second, the decision to proceed to corrective surgery and accurately
12 plan and prepare for the most appropriate intervention could be made without delay. Hiatal
13 hernias are often surgically corrected by veterinarians who may need to review the
14 technique and instrumentation that they have available prior to attempting a procedure.
15 Whilst it would be unusual that a hiatal defect is so large it cannot be closed primarily,
16 advanced reconstructive techniques are sometimes necessary for large diaphragmatic
17 defects. It is important preoperatively to ensure that relevant instrumentation and materials
18 are available (e.g. long handled instruments, reconstructive mesh) and that appropriate
19 techniques have been reviewed in preparation (e.g. rectus abdominis muscle flap
20 reconstruction, appropriate methods to secure mesh implants). It is similarly important for
21 preoperative patient preparation (clipping and aseptic skin preparation) in case the incision
22 needs extending cranially to facilitate thoracotomy. These benefits would not have been
23 obtained so readily with conventional radiography. Previously published cases have
24 documented hernias on static radiographic images that do not discriminate dynamic from
25 static herniation. In this case, CT clearly demonstrated the ability of the abdominal organs
26 to herniate into the thorax, compromise respiratory function and return into the abdomen
27 within a 10-minute window.

28 Type IV hernia is reported as having a low incidence in dogs. There have been only 4
29 previously reported cases (4-7) of paraoesophageal hernias in the veterinary literature and
30 only 2 were type IV hiatal hernias (4, 6). All paraoesophageal hernias occurred in relatively
31 young dogs (4-7) similar to our patient. Two of the previous cases were brachycephalic

1 breeds (6, 7) and vomiting and regurgitation were the most consistent reasons for
2 presentation (4-7). However, this case illustrates that even severely affected dogs may be
3 free from respiratory and gastrointestinal signs. This is possibly due to the dynamic nature
4 of the hernia, and possibly due to masking of respiratory compromise by co-morbidities such
5 as pulmonic stenosis or airway obstruction due to brachycephalia, although exercise
6 intolerance had not been perceived by the dog's owners. It has been reported that the
7 transdiaphragmatic pressure gradient should be manually increased during endoscopy in
8 order to maximise the opportunity of demonstrating hernias and additional abnormalities of
9 the gastro-oesophageal junction (9). We propose that increased diaphragmatic pressure
10 through application of a transabdominal band or positioning the patient on a wedge during a
11 CT examination could similarly demonstrate herniation and should be considered in
12 predisposed dogs, such as brachycephalic breeds (10), undergoing investigation for
13 respiratory or gastrointestinal disease. The case we describe was free from clinical signs and
14 the hernia was detected by chance. Hiatal hernias in companion animals have also been
15 reported as causing dyspnoea, weakness or collapse, probably due to respiratory or cardiac
16 compromise (11). This case confirms that significant respiratory compromise due to
17 entrapment of abdominal viscera can occur.

18 In conclusion this is the first report of subclinical intermittent type IV paraoesophageal
19 hernia diagnosed using CT. In addition, CT provided a definitive diagnosis prior to surgery
20 and demonstrated the highly mobile character of the disease. The surgical approach for
21 different types of hernias is different, and the use of CT-aided rapid surgical planning and
22 management, potentially contributed to a successful outcome in this patient.

23 **LEARNING POINTS/TAKE HOME MESSAGES 3 to 5 bullet points – this is a required**
24 **field**

- 25 • Hiatal hernias might be subclinical and intermittent
- 26 • CT provides a definitive diagnosis and allows detailed characterisation of type of
27 hernia
- 28 • CT provides rapid and accurate surgical planning
- 29 • CT should be considered in patients with suspicion of hiatal hernia

30 **REFERENCES Vancouver style**

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FIGURE/VIDEO CAPTIONS *figures should NOT be embedded in this document*

Figure 1

Transverse, sagittal and dorsal planes of the thorax and cranial abdomen. Panel A is a soft tissue window before contrast injection illustrating normal anatomical positioning of

1 abdominal organs. Panel B is a post contrast administration study, and shows herniation of
2 the stomach, liver and spleen into the thorax, compromising inflation, particularly, of the left
3 lung. Panel C shows that all abdominal organs have returned to their original anatomical
4 position and the oesophagus is fluid filled. White arrows show the diaphragmatic outline. O-
5 oesophagus, G- stomach, S-spleen, L-liver.
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11 Figure 2

12 Schematic diagram showing position of the stomach in relation to diaphragm in A- Normal
13 patient, B- type I, C-type II, D- type III, E- type IV hernia.
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17 **OWNER'S PERSPECTIVE *Optional***

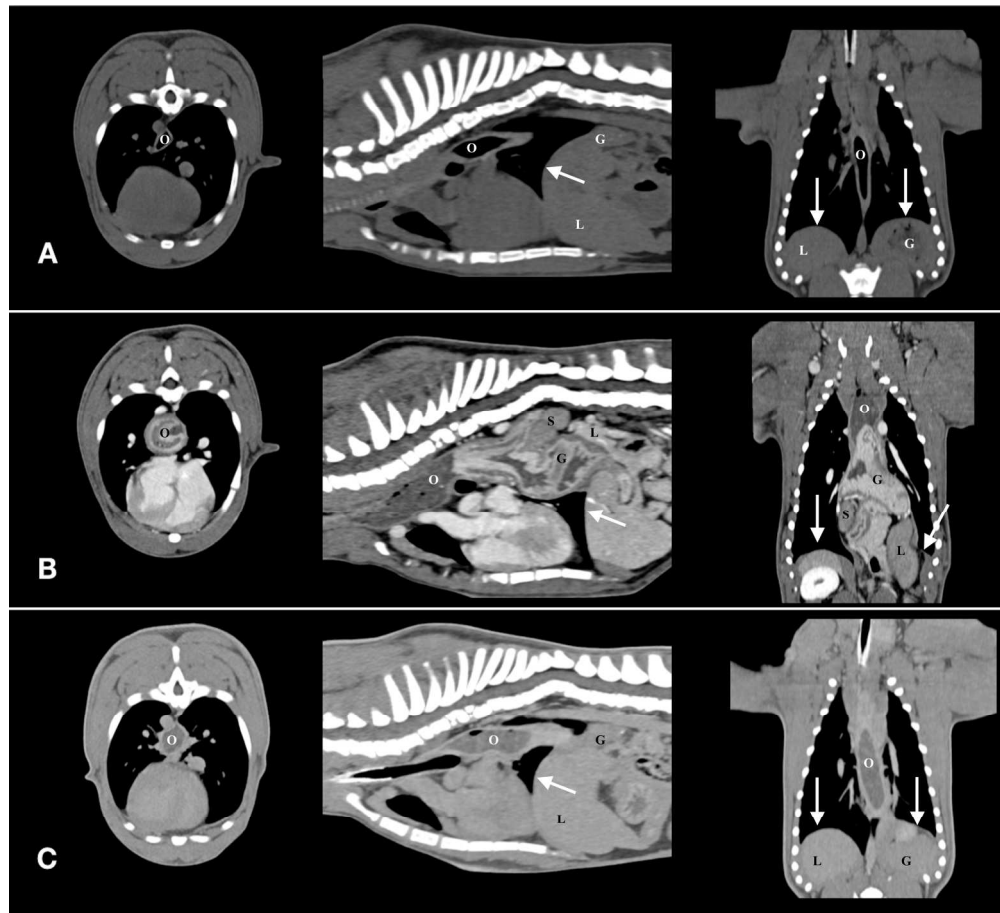
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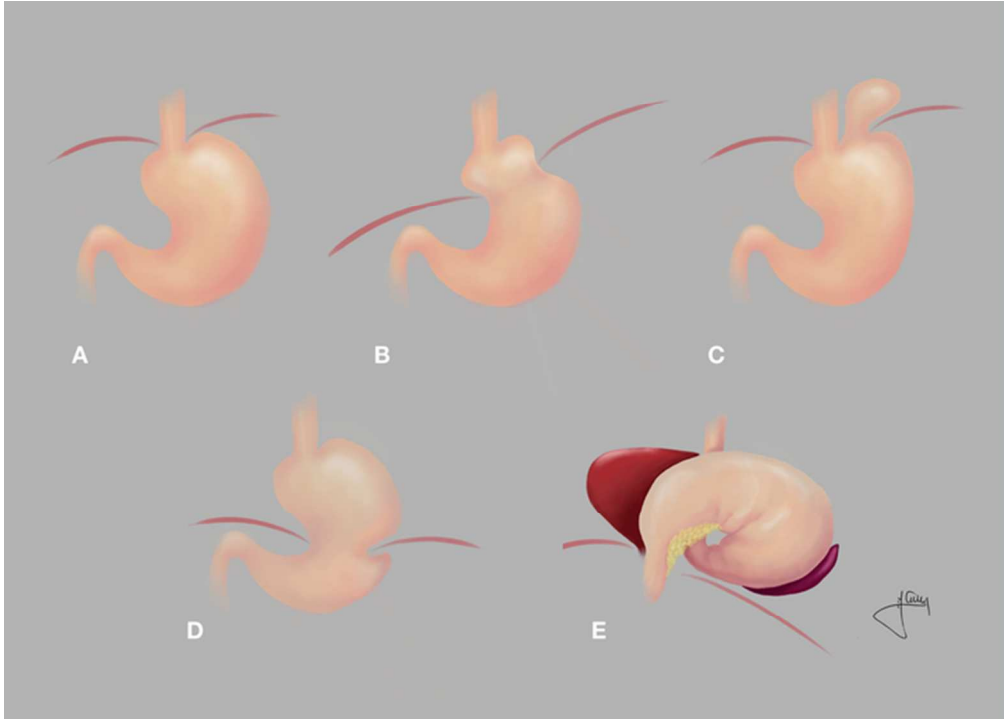
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Transverse, sagittal and dorsal planes of the thorax and cranial abdomen. Panel A is a soft tissue window before contrast injection illustrating normal anatomical positioning of abdominal organs. Panel B is a post contrast administration study, and shows herniation of the stomach, liver and spleen into the thorax, compromising inflation, particularly, of the left lung. Panel C shows that all abdominal organs have returned to their original anatomical position and the oesophagus is fluid filled. White arrows show the diaphragmatic outline. O- oesophagus, G- stomach, S-spleen, L-liver.

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Schematic diagram showing position of the stomach in relation to diaphragm in A- Normal patient, B- type I, C-type II, D- type III, E- type IV hernia.

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