

CASE REPORT

Diagnosis and treatment of a caecal mucocoele in a dog

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An 11-year-old male intact Staffordshire Bull terrier was referred for diabetic ketoacidosis. Abdominal ultrasonographic examination revealed a 5 cm × 2 cm intraluminal caecal mass-like structure. Exploratory laparotomy and typhlectomy were subsequently performed. Histopathology of the caecal mass-like structure was consistent with a caecal mucocoele, defined as a cystic dilation of the caecal lumen with stasis of mucus. This lesion has been previously described in humans, where it is termed an appendiceal mucocoele. The patient was euthanased 58 days post-operatively due to unrelated diabetic complications.

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INTRODUCTION

Appendiceal mucocoeles are a well-described entity in humans. The reported incidence in humans is 0.2 to 0.7% of all excised appendices (Marudanayagam *et al.* 2006), with an increased incidence reported in females compared to males (4:1) and in those over 50 years of age (Aho *et al.* 1973). Appendiceal mucocoele is a collection term for all cases where an accumulation of mucus due to appendiceal obstruction is present (Stocchi *et al.* 2003). Appendiceal mucocoeles in humans are classified into one of three types, according to the histologic characteristics of the epithelium (Stocchi *et al.* 2003):

(1) simple mucocoeles: defined as appendiceal dilation and accumulation of mucus secondary to obstruction of appendiceal outflow.

(2) Benign mucocoele (cystadenoma): defined as a dilated, mucus-filled appendix lined by adenomatous mucosa.

(3) Malignant mucocoele (cystadenocarcinoma): defined as the presence of an adenocarcinoma with a dilated, mucus-filled appendix.

Appendiceal mucocoeles may present as incidental surgical findings or may cause a variety of clinical signs including abdominal pain, a palpable abdominal mass and weight loss (Stocchi *et al.* 2003). In cases of malignant mucocoeles, some neoplastic cells may penetrate the appendiceal wall and seed the peritoneum, leading to accumulation of adhesive, semi-solid mucus in the abdominal cavity in which neoplastic cells can be found; this condition is termed pseudomyxoma peritonei. Retroperitoneal and pleural seeding has also been sporadically reported

(Stevens *et al.* 1997, Takahashi *et al.* 1998, Peek & Beets 1999). Both benign and malignant mucocoeles may lead to appendiceal perforation (Gibbs 1973).

The following databases (PubMed, Ovid, ScienceDirect) and journals (Veterinary Surgery, Journal of Veterinary Internal Medicine, Journal of Small Animal Practice, Journal of the American Veterinary Medical Association) were searched using the keywords “cecal mucocoele” OR “caecal mucocoele” AND “dog” on August 3, 2020. One report (Phillips & Aronson 2012) of a caecal mucocoele was found. In that case, the caecal mucocoele was identified as an apparently incidental finding during diagnostic investigations for complications of a previous renal transplantation. Typhlectomy was performed and the dog was ultimately euthanased due to the development of post-operative septic peritonitis. One case of pseudomyxoma peritonei (Bertazzolo *et al.* 2003) has also been reported.

CASE HISTORY

An 11-year-old male intact Staffordshire Bull terrier was referred for management of diabetic ketoacidosis. The patient had been diagnosed with diabetes mellitus 4 months before presentation and was receiving 0.75 IU/kg lente insulin twice daily. The patient had experienced two suspected hypoglycaemic episodes in the weeks before presentation, characterised by episodes of marked generalised weakness, unresponsiveness and trembling shortly after insulin administration. Further diagnostics (thoracic radiographs, abdominal ultrasound, complete blood count, serum biochemistry, urinalysis, urine culture and canine pancreas-specific lipase)

were performed to screen for inciting causes of diabetic ketoacidosis. On abdominal ultrasound, a focal tubular intraluminal mass-like structure measuring 5 cm × 2 cm was found in the region of the ileocaecocolic junction (Fig 1A, B), deemed to be caecal in origin. The central portion of the mass-like structure appeared irregular, displaying mixed echogenicity and occasional mineralised foci. No evidence of vascularisation was detected within the mass-like structure on colour Doppler examination. The remainder of the caecum was considered to be normal in appearance, with no loss of wall layering. No obvious continuity with the caecal wall was noted. No concurrent focal steatitis or right colic lymphadenopathy was noted. The rest of the abdominal ultrasonographic examination was within normal limits, except for mildly reduced corticomedullary definition in both kidneys.

Due to concerns that the caecal mass-like structure could be a gastrointestinal stromal tumour (GIST), which in humans have been documented to cause hypoglycaemia due to production of insulin-like growth factors (Davda & Seddon 2007), or a possible cause of insulin resistance contributing to diabetic ketoacidosis, exploratory laparotomy was performed. Grossly, the caecal lesion appeared as an intra-luminal 6.5 × 3.5 × 3.0 cm mottled, beige, discrete, mass-like lesion (Fig 2A). There was marked distension of the caecal lumen and extensive ulceration of the mucosa without evidence of rupture. Total typhlectomy was performed by placement and activation of a transverse stapling device at the base of the caecum. Diffuse heterogeneous nodules were visualised throughout the liver. A suture guillotine method was used to biopsy the margin of an affected liver lobe. The remainder of the exploratory laparotomy was unremarkable; the pancreas was grossly normal and no lymphadenomegaly was noted. Recovery from anaesthesia was smooth and uneventful.

On histopathology, residual intact caecal mucosa was simple to pseudo-stratified columnar rather than the expected cryptal architecture and was variably atrophic (Fig 2B, C and D). The caecal lumen was plugged by acidophilic proteinaceous and

cholesterol-rich debris interspersed with mucus, intact and lysed erythrocytes and coarsely granular haemosiderophages. The submucosa and tunica muscularis were variably thinned with areas of fibroplasia, osseous metaplasia and granulomatous or lymphocyte-rich inflammation. The serosal layer was intact and congested with scattered recent haemorrhages. Submucosal, external muscular and serosal layers at the surgical margin were within normal limits. As this lesion was unexpected, two additional board-certified pathologists reviewed the case and all confirmed the diagnosis of caecal mucocoele. Liver histopathology was consistent with acute mild portal hepatitis, most likely attributable to metabolic stress.

Three days post-operatively the patient became inappetent, lethargic and began vomiting. Repeat abdominal ultrasound revealed the pancreas now appeared mildly enlarged, generally hypoechoic and heterogenous, suggesting the development of post-operative pancreatitis. Following intensive supportive care with intravenous fluid therapy and intravenous maropitant (1 mg/kg every 24 hours), ondansetron (0.5 mg/kg every 12 hours) and omeprazole (1 mg/kg every 12 hours), the patient's clinical signs resolved. He was transitioned back on to subcutaneous insulin and discharged 8 days after surgery. The patient re-presented a subsequent eight times over the following weeks due to repeated bouts of diabetic ketosis and pancreatitis. He was subsequently also diagnosed with exocrine pancreatic insufficiency, based on a trypsin-like immunoreactivity result of 3 µg/L (reference interval 6–35 µg/L). The patient was euthanased 58 days post-operatively due to quality of life concerns associated with poorly-controlled diabetes mellitus and chronic pancreatitis. *Post-mortem* examination was declined.

DISCUSSION

In human medicine some patients with caecal mucocoeles present with abdominal pain, a palpable abdominal mass, vomit-

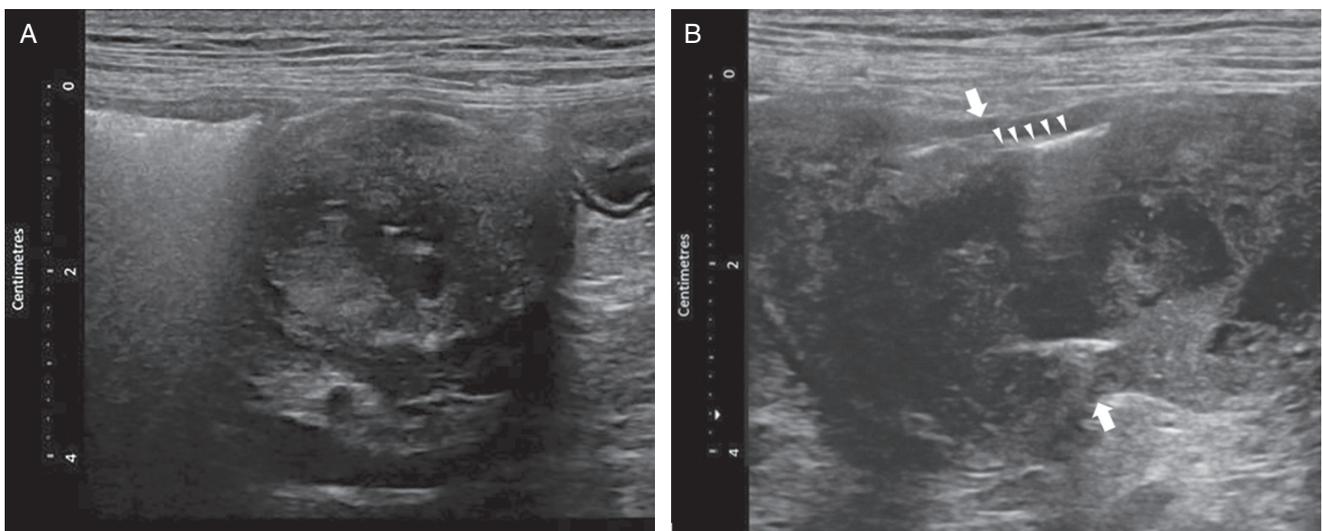


FIG 1. (A) Transverse ultrasonographic view of the caecal mucocoele. Note the heterogeneous central portion with occasional mineralised foci. (B) Longitudinal ultrasonographic view of the caecal mucocoele. White arrowheads indicate the location of the caecal walls. The hyperechoic line indicated by white arrowheads represents gas within the caecal lumen

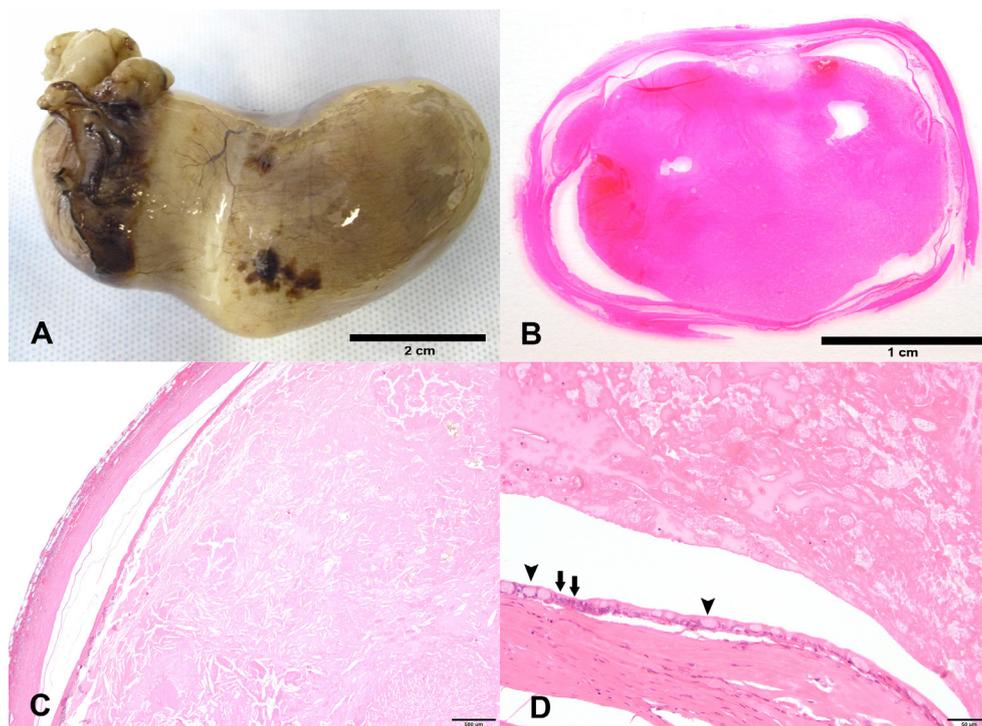


FIG 2. (A) Gross image of the caecum following surgical resection. The caecum is markedly dilated. The serosa is bright and intact. (B) Subgross photomicrograph of a cross section of the caecal mucocoele. The lumen is markedly dilated with proteinaceous eosinophilic material and the wall is variably thinned. (C) Photomicrograph at low power magnification of the caecal mucocoele. A large plug of brightly eosinophilic, proteinaceous material markedly distends the caecal lumen and compresses the lining epithelium. Multiple acicular cholesterol clefts are embedded within the proteinaceous material. (D) Photomicrograph at high power magnification of the caecal mucocoele. The lining epithelium is diffusely flattened and compressed with diffuse loss of the normal tubular glands. The lining epithelium consists of absorptive cells (arrows) and mucous-secreting goblet cells (arrowheads). Cellular atypia is not observed

ing, weight loss or gastrointestinal bleeding (Garcia Lozano *et al.* 2010, Sugarbaker 2009b). However, approximately 50% of human cases are diagnosed as incidental findings (Merran 1997, Pickhardt *et al.* 2002). Although there was initially concern that the caecal mass-like lesion in our patient could have been a contributing factor to the patient's diabetic ketoacidosis and/or historical suspected hypoglycaemic episodes, given the subsequent diagnosis of caecal mucocoele, it is ultimately deemed to have been an incidental finding in our canine patient. The gross and histopathological findings in this case were most consistent with a simple mucocoele. No adenomatous change or cellular atypia were observed, which consequently rules out a benign mucocoele (cystadenoma) and malignant mucocoele (cystadenocarcinoma).

In human medicine, pre-operative diagnosis of malignant appendiceal mucocoeles is considered important for the selection of surgical methods to prevent peritoneal dissemination, peri-operative complications and the possible need for repeat surgery (Dhage-Ivatury & Sugarbaker 2006, Sugarbaker 2009a). In 2003 Stocchi *et al.* described clinical, diagnostic and surgical variables associated with malignancy of appendiceal mucocoeles in humans. They found that there was significant association between the presence of symptoms (particularly abdominal pain and weight loss) with malignancy. Other variables associated with malignancy included the presence of a palpable abdominal mass, and the presence of pseudomyxoma peritonei or mucocoele extravasation. Mucocoele size was not associated with

malignancy, however, cystadenomas were typically significantly larger than simple mucocoeles. Documentation of additional cases of canine caecal mucocoeles is needed to determine whether such variables are significant in dogs. Abdominal ultrasound, CT, and colonoscopy are the primary means of diagnosis of appendiceal mucocoeles described in humans. The ultrasonographic appearance has been described as a cystic, encapsulated lesion, firmly attached to the caecum, with liquid content and an internal variable echogenicity related to mucus density (Zissin *et al.* 1999). CT is regarded as the gold-standard for diagnosis of appendiceal mucocoeles in humans, with characteristic CT findings including an appendiceal lumen >13 mm diameter, with cystic dilatation and calcification of the appendiceal walls (Pickhardt *et al.* 2002, Francica *et al.* 2006, Ruiz-Tovar *et al.* 2007, Bennett *et al.* 2009, Lozano *et al.* 2010). Colonoscopy may reveal the presence of yellow discharge at the appendiceal orifice, and in some cases a pathognomonic "sign of the volcano," *i.e.* a mass with a central crater, from which mucus is discharged (Hamilton & Stormont 1989).

In our canine patient, a caecal mass-like structure was visualised on abdominal ultrasound. Our top differential diagnosis for the caecal mass-like structure was a GIST, which in humans have been documented to cause hypoglycaemia due to production of insulin-like growth factors (Davda & Seddon 2007) and could have explained the suspected hypoglycaemic episodes noted before presentation. Most caecal masses in dogs are malig-

nant, with commonly reported diagnoses including GIST, leiomyosarcoma and leiomyoma (Maas *et al.* 2007). In humans, ultrasonographic features of GISTs include a large extramural tumour arising from the muscularis layer, that rarely affects the mucosal layer, and often contain regions of cavitation (Wronski *et al.* 2009), however, species differences in anatomy limit extrapolation of human imaging findings to canine patients. In veterinary medicine, ultrasonographic characteristics of smooth muscle tumours include eccentric masses with cavitations, but these were described before our understanding of GISTs (Myers & Penninck 1994) as a distinct entity. A more recent publication did not show a statistically significant difference between GISTs and non-GISTs using the ultrasonographic features of echogenicity, echotexture, size, bowel wall distribution/morphology or cavitation (Hobbs *et al.* 2015). A caecal mucocoele was not considered a differential diagnosis for the caecal mass-like lesion seen on ultrasound in our patient, given the paucity of reported cases in dogs. This case shows that mucocoele should be considered as an additional differential diagnosis for a canine caecal mass-like structure. The ultrasonographic appearance of the caecal mucocoele in this patient shares some common features with the described ultrasonographic appearance in humans, including an internal mixed echogenicity (Zissin *et al.* 1999) and lack of vascularisation on Doppler examination (Paladino *et al.* 2014, Panagopoulos *et al.* 2017), features which may help distinguish mucocoeles from neoplastic causes of caecal mass-like lesions. Documentation of additional cases of caecal mucocoeles is needed to further characterise the imaging findings and optimal means of diagnosis in dogs.

Exploratory laparotomy and typhlectomy were performed in our patient due to concerns that the caecal mass-like structure could be a GIST. In humans, exploratory laparotomy is preferred to laparoscopy to decrease the risk of mucocoele rupture and pseudomyxoma peritonei, and to facilitate full inspection of the abdominal cavity (Dhage-Ivatury & Sugarbaker 2006, Karakaya *et al.* 2008, Khan *et al.* 2010, Sugarbaker 2009a). Thorough abdominal exploration is vital, as appendiceal mucocoeles have been associated with other tumours in people, particularly colonic adenocarcinomas and ovarian tumours (Kahn & Friedman 1979). In humans appendectomy is indicated for simple mucocoeles, mucosal hyperplasia and for most cystadenomas. Typhlectomy is indicated for cystadenomas where appendectomy alone is not surgically feasible while right hemi-colectomy is recommended for cystadenocarcinomas (Kahn & Friedman 1979, González Moreno *et al.* 1998). In our patient, total typhlectomy was performed. Due to the paucity of other canine cases, and anatomical differences between species, the optimal surgical management of caecal mucocoeles in dogs is unknown. However, typhlectomy is advised given the reports of spontaneous appendiceal rupture in humans (Gibbs 1973).

Postoperatively, human patients with benign mucocoeles have an excellent prognosis with 5-year survival rates of 91–100%. However 5-year survival rates in cases of malignant mucocoeles are significantly lower (25%) due to complications of pseudomyxoma peritonei (Aho *et al.* 1973). As our patient's mucocoele was a simple mucocoele, we anticipate his prognosis would have

been excellent in the absence of concurrent disease, however documentation of further canine cases is needed to more accurately determine prognosis in dogs with this condition.

In conclusion, caecal mucocoele should be considered as a differential diagnosis for a caecal mass in canine patients. The detection of a non-vascularised structure with internal mixed echogenicity within the caecum on ultrasound examination should raise suspicion for a possible mucocoele. Based on human literature, exploratory laparotomy and typhlectomy are indicated for suspected caecal mucocoeles, although description of further cases is needed to determine the optimal means of diagnosis and management, and to determine the prognosis of these cases.

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Conflict of Interest

None of the authors of this article has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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