University of Glasgow

Fulton, E., Hammond, G., Marchesi, F., Hernandez Perez, M. and Ridyard, A. E. (2022) Feline emphysematous gastritis in a cat with pancreatitis and secondary hepatic lipidosis. Journal of the American Animal Hospital Association, 58(4), pp. 207-212.

There may be differences between this version and the published version. You are advised to consult the publisher's version if you wish to cite from it.

https://eprints.gla.ac.uk/275292/

Deposited on: 29 November 2022

Enlighten – Research publications by members of the University of Glasgow
https://eprints.gla.ac.uk

JAAHA-MS-7228

Case Reports

Feline Emphysematous Gastritis in a Cat with Pancreatitis and Secondary Hepatic Lipidosis

<rrh>Feline emphysematous gastritis

Emily Fulton, BVSc, Gawain Hammond, MA, VetMB, MVM, CertVDI, DECVDI, FHEA, Francesco Marchesi, DVM, PhD, DECVP, Marta Hernández Pérez, DVM, Alison E. Ridyard, BVSc, DSAM, DECVIM-CA

From the University of Glasgow, Glasgow, Scotland.

Correspondence: e.fulton.2@research.gla.ac.uk (E.F.)

Accepted for publication: June 3, 2021.

FNA (fine-needle aspirate)

ABSTRACT

A 7 yr old female neutered domestic short hair was presented with a 2 mo history of lethargy and hyporexia progressing to anorexia. Initial diagnostics indicated pancreatitis with secondary hepatic lipidosis. Supportive care, including the placement of an esophageal feeding tube, was initiated. The feeding tube was removed traumatically by the cat and thus replaced. The cat acutely deteriorated while hospitalized, developing marked hypersalivation and an obtunded mentation. Radiographs were taken to confirm placement of the feeding tube in case tube dislodgement was contributing to the hypersalivation; results confirmed appropriate positioning and gastric pneumatosis. Despite intensified medical management, the patient suffered cardiopulmonary arrest 7 days after hospital admission. Post-mortem examination confirmed necrotizing gastritis with emphysema alongside segmental mucosal necrosis in the jejunum, focal pancreatic necrosis, and diffuse hepatic lipidosis. Gas in the gastric wall is a rare finding in veterinary medicine and can arise due to gastric pneumatosis or emphysematous gastritis; there are scant reports of either in feline medicine. This report documents a case of emphysematous gastritis in a cat with concurrent pancreatitis and hepatic lipidosis. The cat developed emphysematous gastritis without undergoing gastrointestinal surgery which is currently the only reported feline predisposing factor for development.

<1>Introduction

The presence of air within any tissue is known as pneumatosis. Air can rarely occur within the wall of any portion of the gastrointestinal tract. In human literature, the colon is the most frequently reported site for pneumatosis, with gastric pneumatosis occurring much less commonly.[1] There are two categories of gastric pneumatosis reported in human medicine; the first is gastric emphysema, carrying a favorable prognosis, and the second is emphysematous gastritis, which is a much more critical condition, with reported mortality rates of between 33.3 and 59.4%.[2] The distinction between emphysematous gastritis and gastric emphysema is largely based on the presence or absence of gas-forming organisms. In the case of gastric emphysema, bacteria are absent; an increase in gastric intraluminal pressure is hypothesized to be the underlying trigger, with increased pressures leading to weaknesses in the mucosa, enabling the entrance of air. In humans, this condition has been associated with severe vomiting, pyloric stenosis, and anorexia nervosa among other predisposing factors.[3–5] Conversely, emphysematous gastritis is defined by the presence of bacteria within the gastric wall. Various bacteria have been implicated in human emphysematous gastritis, with *Streptococci* sp, *Escherichia coli, Enterobacter* spp, *Clostridium welchii*, and *Staphylococcus aureus* being most frequently reported.[6] Predisposing factors include ingestion of corrosive substances, alcoholism, abdominal surgery, and diabetes mellitus.[7] Reports of emphysematous gastritis in veterinary medicine are scant. In the cat, there have been just seven reports of gastric pneumatosis and a single report of pneumatosis intestinalis.[8–14] The single reported predisposing factor in cats for the development of emphysematous gastritis is gastrointestinal surgery.[8] Canine gastric pneumatosis is also uncommon, and its occurrence is most often associated with the presence of gastric dilation and volvulus.[15] Here, we report a case of emphysematous gastritis in a cat who had been diagnosed with pancreatitis with

secondary hepatic lipidosis; the cat was medically managed and had not undergone gastrointestinal surgery.

<1>Case Report

A 7 yr old, female neutered domestic short hair was referred to the Internal Medicine Department at the University of Glasgow for investigation of raised hepatic enzymes and increased total bilirubin. The cat's appetite had been slightly reduced for the previous 2 mo, with a significant deterioration in her condition noted over the 2 wk before presentation, with hyporexia progressing to anorexia and lethargy. Two days before referral, the owners had noticed that her pinnae and mucous membranes had become icteric.

On physical examination, the cat was quiet but alert. Her sclera, pinnae, and mucous membranes were all confirmed to be jaundiced; the rest of the examination was unremarkable; the cat had a body condition score of 5/9.[16] Routine clinicopathological testing was performed. Hematology documented only a mild lymphopenia (0.617×10^9/L; reference range, $1.5–7 \times 10^9$/L). Serum biochemistry showed marked increases in alkaline phosphatase (458 U/L; reference range, 0–100 U/L), aspartate transaminase (94 U/L; reference range, 0–30 U/L), and alanine transaminase (252 U/L; reference range, 0–35 U/L); gamma-glutamyl transferase activity was within normal limits (15 U/L; reference range, 0–15 U/L); total bilirubin was markedly increased (180 μmol/L; reference range 0–10 μmol/L). Additionally, mild hypertriglyceridemia (1.06 mmol/L; reference range, 0–0.6 mmol/L), mild total hypercalcemia (2.89 mmol/L; reference range,1.6–2.65 mmol/L), mild hyperglycemia (8.9 mmol/L; reference range, 4.3–6.6 mmol/L), and hypophosphatemia (0.83 mmol/L; reference range,1.29–2.84 mmol/L) were noted. Urinalysis was unremarkable aside from the presence of bilirubinuria.

A coagulation profile was performed and showed mild prolongation in prothrombin time (19.3 s; reference range 9–14 s); activated partial thromboplastin time and fibrinogen were within normal limits. Abdominal ultrasonography was performed on the day of admission and revealed changes compatible with hepatic lipidosis and pancreatitis: The liver was enlarged and diffusely hyperechoic, and the pancreas was mildly enlarged with a diffusely hypoechoic appearance with the surrounding mesentery being marginally hyperechoic. There was no evidence of dilation of the biliary tract, and the stomach was noted to be normal.

To further define the cause of the serum biochemical changes, cholecystocentesis and liver fine-needle aspirates (FNAs) were performed under general anesthesia. Bile culture was sterile, and cytology revealed no cells or microorganisms. Cytology of the liver aspirates was most consistent with hepatic lipidosis. Culture of an FNA of the liver parenchyma (placed into an enriched medium blood culture bottle[a]) yielded a nonhemolytic *Staphylococcus*, which, in the absence of an inflammatory component to the FNAs, was most likely to represent contamination. The investigations concluded that the cat had developed hepatic lipidosis resulting from anorexia due to pancreatitis.

To facilitate nutritional support and management of hepatic lipidosis, an esophageal feeding tube was placed using a standard curved forceps technique and was secured in place with a finger trap suture. Supportive therapy was then initiated for the treatment of suspected pancreatitis with secondary hepatic lipidosis. Buprenorphine[b] (0.2 mg/kg *q* 6 hr) and maropitant[c] (1 mg/kg *q* 24 hr) were administered IV, and IV fluid therapy[d] was initiated (4 mL/kg/hr). Unfortunately, due to the fractious nature of the patient, the feeding tube was

[a] Signal Blood Culture System; Oxoid LTD, Basingstoke, Hampshire, United Kingdom
[b]Vetergesic; Ceva Animal Health, Ltd., Amersham, Buckinghamshire, United Kingdom
[c]Cerenia; Zoetis UK, Ltd., Leatherhead, Surrey, United Kingdom
[d]Vetivex (Hartmann's) 11 Solution for Infusion; Dechra Veterinary Products, Shrewsbury, Shropshire, United Kingdom

traumatically removed by the cat shortly after recovery, necessitating replacement of the tube the following day with no complications incurred during placement or recovery. Radiographs were taken and confirmed successful placement, and at that point there were no abnormalities within the cranial abdomen. Feeding via the esophageal tube was started at a third of resting energy requirements because of the previous anorexia and was initially tolerated well. Oral ursodeoxycholic acid[e] (15 mg/kg *q* 24 hr) and S-adenosyl methionine/silybin[f] (90 mg/cat *q* 24 hr) were also introduced. Within 24 hr of initiation of tube feeding, the cat began to develop marked hypersalivation. Hematology and serum biochemistry were repeated and were unchanged aside from the development of mild hypokalemia (3.2 mmol/L; reference range 3.5–5.8 mmol/L). The opioid dose was halved and IV omeprazole[g] (1 mg/kg *q* 12 hr) started in case of esophagitis; potassium supplementation was also added to the IV fluid therapy. Mild hyperammonemia was detected (109 μmol/L; reference range, <60 μmol/L) raising the possibility of hepatic encephalopathy contributing to the cat's clinical presentation.

Overnight on day 6 of hospitalization (3 days after the feeding tube placement), the cat deteriorated significantly, becoming severely depressed and unwilling to stand. Indirect blood pressure measurements documented marked hypotension with a reading being unobtainable. Repeat serum biochemistry showed a moderate azotemia (creatinine 224 μmol/L; reference range, 71–212 μmol/L and urea 24.9 mmol/L; reference range, 5.7–12.9 mmol/L), which was thought to be prerenal in origin. Hematology showed a persistent lymphopenia, and, although the neutrophil count remained within the reference range, there was a left shift with a significant band neutrophilia (2.08×10^9/L; reference range: 0–0); on smear analysis, the neutrophils showed marked toxic changes. Thoracic radiographs were

[e]Destolit; Norgine Pharmaceuticals, Ltd., Harefild, Uxbridge, United Kingdom
[f]Denamarin; Protexin Veterinary, Somerset, United Kingdom
[g]Omeprazole; Servipharm Limited, Harrow, Greater London, United Kingdom

repeated to assess for aspiration pneumonia and to again check the position of the feeding tube, which confirmed appropriate feeding tube placement to the level of the 9th rib. Although there was no overt pulmonary or intrathoracic pathology, there was moderate gastric dilation due to gas (with the stomach extending beyond the 13th rib), and intramural gas was present in the ventral and caudo-lateral regions the gastric wall (**Figure 1A**), consistent with gastric pneumatosis. Functional ileus was also suspected based on the radiographic findings. Repeat abdominal ultrasounds showed an unchanged appearance to the liver; assessment of the stomach showed gas infiltration into the wall along a substantial area of the greater curvature of the stomach (Figure 1B). The jejunum and ileum were moderately distended with fluid; there was no evidence of obstruction, although, as with the radiographs, there was suggestion of ileus. Because of the clinical suspicion of sepsis, blood and urine samples were then collected and submitted for culture; both were reported to be sterile.

The patient received several fluid[d] boluses (5–10 mL/kg over 20 min) to positive effect and was then started on 6 mL/kg/hr of continued fluid therapy; serial blood pressure readings were taken, and systolic blood pressure was maintained above 60 mm Hg. IV cefuroxime[h] (20 mg/kg *q* 8 hr) and metronidazole[i] (10 mg/kg *q*12 hr) were administered because of the suspicion of sepsis; sucralfate[j] (250 mg/cat *q* 8 hr) was administered via the feeding tube. Despite intensification of medical management, the cat suffered cardiopulmonary arrest 24 hr after the documentation of gastric pneumatosis.

Post-mortem evaluation was performed within 24 hr of death. There was mild pale-yellow discoloration of subcutaneous and visceral adipose tissue (jaundice). Approximately 40 mL of straw-colored fluid was present in the abdominal cavity. The stomach showed focally extensive red discoloration of the serosal surface along the greater curvature,

[h]Zinacef; GlaxoSmithKline UK, Brentford, Middlesex, United Kingdom
[i]Metronidazole 5 mg/mL; B. Braun Melsungen AG, Melsungen, Germany
[j]Antepsin; Laboratoria Baldacci S.P.A., Pisa, Italy

particularly in the antrum region. Approximately 80 mL of gray/green fluid content was noted in the gastric lumen. The gastric mucosa showed extensive green/yellow to dark red discoloration with sparse small foci and irregular areas of red discoloration suggestive of mucosal erosions (**Figure 2A**). In the areas of mucosal discoloration, the gastric wall was thickened with slight crepitation at touch (emphysema). Histological examination confirmed extensive necrosis of the gastric mucosa with superficial bacteria including Gram-positive cocci and Gram-negative rods and slender bacilli (Figure 2B); there were multifocal and extensive round or irregular clear spaces in the submucosa (Figure 2C), consistent with gas bubbles (emphysema) and diffuse edema affecting the submucosa and variably extending to the muscularis. There was variable sparse infiltration of hypersegmented and degenerate neutrophils in the submucosa and most prominently associated with the disrupted muscularis mucosae (Figure 2D). Focally extensive mucosal necrosis with associated Gram-positive and Gram-negative bacteria was also present in the proximal jejunum. Changes in the pancreas included a focal area of acinar necrosis and necrosis with saponification of adjacent peripancreatic adipose tissue. Microscopic changes in the liver were consistent with hepatocellular lipidosis.

Fluorescence in situ hybridization analysis was performed on tissue sections from the stomach and proximal jejunum and indicated that the majority of bacteria present were *E coli* alongside clusters of clostridia.

<1>Discussion

There are sparse reports of feline gastric pneumatosis in veterinary literature. There are four reports of emphysematous gastritis, two of which were associated with abdominal surgery; one cat underwent exploratory laparotomy to obtain biopsies (including gastric biopsy) and the other to remove foreign material from the gastrointestinal tract.[8,9] In a third case, FNAs were taken from a thickened portion of small intestine.[10] The fourth case occurred in a cat

with concurrent hepatic portal venous gas; this cat had undergone endoscopy retrieval of gastric foreign material alongside endoscopic biopsies of the stomach and duodenum.[14] In all cases, gastrointestinal tract intervention was thought to be at least partially responsible for the development for feline emphysematous gastritis; this is also a reported risk factor in humans.[7]

In the current case, the cat was diagnosed with pancreatitis causing secondary hepatic lipidosis and underwent neither gastrointestinal surgery nor any sampling of the gastrointestinal tract, thus representing a case of emphysematous gastritis without any previous interference to the abdominal gastrointestinal tract. Although the placement of the esophageal feeding tube and subsequent need for replacement was initially considered as a potential reason for the development of gastric pneumatosis in this case, the lack of submucosal gas tracking on radiographs and the unremarkable appearance of the esophagus and surrounding tissue at post mortem made this unlikely. Gastric emphysema has been reported as a complication of nasogastric tube placement in a human, resulting from extension of the nasogastric tube into the gastric mucosa.[17] However, direct gastric trauma during feeding tube placement in this case was considered unlikely.

In human medicine, emphysematous gastritis has been reported secondary to acute pancreatitis.[18] In this case, it was hypothesized that age-related immunocompromise and patient co-morbidities had led to compromise of the protective function of the stomach wall. Interestingly, pancreatitis was also present in a previous case of feline emphysematous gastritis as well as in the case of feline gastric emphysema.[8,11] In the current case, it is likely that the cause of emphysematous gastritis was multifactorial, but we hypothesize that regional peritonitis secondary to pancreatitis, hypotension, and local vascular events such as thromboembolism contributed to compromise of the gastric mucosa allowing colonization with bacteria. The use of omeprazole could have contributed to gastrointestinal dysbiosis, leading to the proliferation of noncommensal bacteria within the stomach. In humans, the use

of proton pump inhibitors is linked to gastric bacterial overgrowth and development of enteric infection, such as enteric *C difficile*, due to the reduced increased gastric pH that results from proton pump inhibitor use.[19] Alternatively, the development of ileus could have altered the bacterial population present within the stomach; several studies in both the cat and dog have shown that acute gastrointestinal disease can be linked with changes within the gastrointestinal microbial population.[20]

Differentiation of emphysematous gastritis from gastric emphysema based on radiography alone can be challenging. In cases of emphysematous gastritis in humans, numerous mottled cystic lesions are usually observed within the wall of the gastric mucosa on radiographs in comparison to the linear pattern that is more commonly associated with gastric emphysema.[21] However, the linear pattern seen with gastric emphysema is not pathognomonic and can also be observed in cases of emphysematous gastritis.[21] In the majority of cases, it falls to the clinical assessment of the patient to determine whether gastric emphysema or emphysematous gastritis seems most likely. In this case, because of the rapid deterioration, development of sepsis, and ultimately fatal outcome, emphysematous gastritis was strongly suspected.

Historically, in human medicine, emphysematous gastritis was managed with surgical debridement of necrotic tissue. However, more recently, there has been a switch toward early medical management and endoscopic evaluation to assess for the need for surgical intervention (for example, evidence of gastric infarction or perforation); this change in approach has been credited with a reduction in mortality rates.[2] Medical management in humans often consists of broad spectrum antibiotics, supportive IV fluid therapy, and the use of parenteral nutrition to permit gastrointestinal tract to recover.[23,24]

Although feline emphysematous gastritis is a rare occurrence, if encountered in the future, rapid administration of antibiotic therapy as in humans is also advocated. Culture and

sensitivity was unfortunately not performed either ante or post mortem in this case; however, fluorescence in situ hybridization analysis indicated *E coli* as the predominant bacteria present in association with the mucosal lesions; clusters of clostridia were also noted. Previous reports of feline emphysematous gastritis implicate *Enterococcus* sp., *E coli*, *Candida albicans*, *Lactobacillus minitus*, and *Clostridium perfringens* Type A as causative agents.[8–10] Therefore, a broad-spectrum antibiotic such as amoxicillin-clavulanate should be considered as a first choice to cover for the range of organisms that may be present. In humans, culture and sensitivity of the gastric fluid has reported to be of use for tailoring antibiotic therapy.[25]

Administration of nutrition bypassing the stomach is also of importance. Total parenteral nutrition in veterinary medicine can be complex and is not without its own inherent risk, such as the development of sepsis.[26] In one previous feline case report in which the cat survived to discharge, a jejunostomy tube was placed to allow food to bypass the stomach, and thus this procedure may worth considering in future cases.[8]

Of the previously reported case of feline emphysematous gastritis, two survived and the third was euthanized. Emphysematous gastritis proved fatal in this case, thus providing a reminder of the severity of the condition. This case represents a cat with emphysematous gastritis with no prior abdominal surgery or procedures related to the gastrointestinal tract. The cat had been diagnosed with pancreatitis, and therefore it is suggested that emphysematous gastritis may represent a rare and severe complication of this condition.

REFERENCES

1. Hawn MT, Canon CL, Lockhart ME, et al. Serum lactic acid determines the outcomes of CT diagnosis of pneumatosis of the gastrointestinal tract. *Am Surg* 2004;1:19–23.
2. Watson A, Bul V, Staudacher J, et al. The predictors of mortality and secular changes in management strategies in emphysematous gastritis. *Clin Res Hepatol Gastroenterol* 2017;41:e1–7.
3. Majumder S, Trikudanathan G, Moezardalan K, et al. Vomiting-induced gastric emphysema: a rare self-limiting condition. *Am J Med Sci* 2012;343:92–3.
4. Lester PD, Budge AF, Barnes JC, et al. Gastric emphysema in infants with hypertrophic pyloric stenosis. *AJR Am J Roentgenol* 1978;131:421–3.
5. Kim T, Kim U, Song H. A case of gastric emphysema in anorexia nervosa presenting as acute gastric distension. *Korean J Gastroenterol* 2012;60:315–9.
6. Yalamanchili M, Cady W. Emphysematous gastritis in a haemodialysis patient. *South Med J* 2002;96:84–8.
7. Al-Jundi W, Shebl A. Emphysematous gastritis: case report and review of the literature. *Int J Surg* 2007;6:e63–6.
8. Rhue KE, Biddick AA, Foltz KM, et al. Emphysematous gastritis in a cat. *J Vet Emerg Crit Care (San Antonio)* 2018;28:596–602.
9. Lang LG, Greatting HH, Spaulding KA, et al. Imaging diagnosis – Gastric pneumatosis in a cat. *Vet Radiol Ultrasound* 2001;54:658–60.
10. Burn J, Rousset N, Henderson D, et al. Emphysematous gastritis associated with *Clostridium perfringens* type A in a cat. *Vet Rec Case Rep* 2017;5:e000540.
11. Silveira C, Benigni L, Gugich K, et al. Feline gastric pneumatosis. *JFMS Open Rep* 2018;4:2055116918782779.

12. Thierry F, Ferreira MF, Paterson GK, et al. Canine and feline emphysematous gastritis may be differentiated from gastric emphysema based on clinical and imaging characteristics: Five cases. *Vet Radiol Ultrasound* 2019;60:136–44.

13. Walczak R, Paek M, Suran J, et al. Radiography and ultrasonography of pneumatosis intestinalis in a cat. *Vet Radiol Ultrasound* 2018;61:E26–30.

14. Spiller KT, Eiseberg BW. Extensive hepatic portal venous gas and gastric pneumatosis in a cat. *Vet Med Sci* 2021;7:593–9.

15. Fischetti AJ, Saunders MH, Drobatz KJ. Pneumatosis in canine gastric dilation-volvulus syndrome. *Vet Radiol Ultrasound* 2004;45:205–9.

16. La Flamme D. Development and validation of a body condition score system for cats: a clinical tool. *Feline Pract* 1997;25:13–8.

17. Zenooz N, Robbin M, Perez V. Gastric pneumatosis following nasogastric tube placement: a case report with literature review. *Emerg Radiol* 2007;13:205–7.

18. Bloodworth LL, Stevens PE, Bury RF, et al. Emphysematous gastritis after acute pancreatitis. *Gut* 1987;28:900–2.

19. Schmid SM, Suchodolski JS, Price JM, et al. Omeprazole minimally alters the fecal microbial community in six cats: a pilot study. *Front Vet Sci* 2018;5:79.

20. Honneffer JB, Minamoto Y, Suchodolski JS. Microbiota alterations in acute and chronic gastrointestinal inflammation of cats and dogs. *World J Gastroenterol* 2014;20:16489–97.

21. Grayson DE, Abbott RM, Levy AD, et al. Emphysematous infections of the abdomen and pelvis: A pictorial review. *Radiographics* 2002;22:543–59.

22. Williford ME, Foster WL, Halvorsen RA, et al. Emphysematous gastritis secondary to disseminated strongyloidiasis. *Gastrointest Radiol* 1982;7:123–6.

23. Paul M, John S, Menon M, et al. Successful medical management of emphysematous gastritis with concomitant portal venous air: a case report. *J. Med Case Rep* 2010;4:140.

24. Chen H. Education and imaging. Gastrointestinal: emphysematous gastritis. *J Gastroenterol Hepatol* 2016;31:9.

25. Moosiv AR, Saravolatz LD, Wong DH, et al. Emphysematous gastritis: Case report and review. *Arch Clin Infect Dis* 1990;12:848–55.

26. Lippert AC, Fulton RB, Parr AM. A retrospective study of the use of total parenteral nutrition in dogs and cats. *J Vet Intern Med* 1993;7:52–64.

FIGURE 1 *Imaging.* (A) *Radiograph of the thorax and cranial abdomen demonstrating gastric pneumatosis (*solid arrow*).* (B) *Short-axis ultrasound scan of the body of the stomach showing intramural hyperechogenicities (*arrow heads*) with distal reverberation indicating gastric pneumatosis.*

FIGURE 2 *Cat stomach.* (A) *Macroscopic findings at post-mortem examination: The necrotic mucosal surface shows an extensive area of green discoloration with peripheral and sparse red mottling.* (B) *Large numbers of bacteria associated with the necrotic mucosa, including Gram-positive cocci (*dark blue dots*) and Gram-negative rods (red) either sparse or in clusters. Gram stain. Original magnification ×40.* (C) *Diffuse necrosis of the mucosa (*arrowheads*). The submucosa is expanded by multifocal irregular and variably coalescing clear spaces consistent with gas bubbles (*asterisks*). HE stain. Original magnification ×1.25.* (D) *Diffuse necrosis of the mucosa (*asterisk*). Diffuse necrosis of the muscularis mucosae and submucosa with associated infiltration of degenerate neutrophils (*arrowheads*). HE stain. Original magnification ×10. HE, hematoxylin and eosin.*