

Gastric mucormycosis in a cat

Emilio Mavilio¹  and Enrico Bottero²

Journal of Feline Medicine and Surgery Open Reports
1–5

© The Author(s) 2025

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/20551169241301914

journals.sagepub.com/home/jfmsopenreports

This paper was handled and processed by the European Editorial Office (ISFM) for publication in *JFMS Open Reports*



Abstract

Case summary This report describes a case of gastric mucormycosis in a young Ragdoll cat with a 5-day history of vomiting. Physical examination detected mild dehydration and tenderness was elicited on abdominal palpation. The results of blood work-up and radiographic study were unremarkable; however, abdominal ultrasonographic examination revealed multiple hyperechoic neoformations at the level of the pyloric antrum, which were confirmed on endoscopic examination. Non-septate hyphae of irregular diameter with a branched appearance were observed on cytology, and histological examination revealed severe diffuse necrotising and granulomatous gastritis with the presence of intralesional fungal hyphae indicative of mucormycosis, which was confirmed by PCR tests. Antifungal therapy with ketoconazole in addition to supportive treatment temporarily improved the clinical condition. Lethargy, fever and abdominal effusion developed in the following days. Cytological examination of abdominal fluid was compatible with septic peritonitis and, given the severity of the condition, euthanasia was opted by the owners. Post-mortem examination confirmed septic peritonitis resulting from perforation of the gastric wall at one of the neoformations of the pyloric antrum.

Relevance and novel information To the authors' knowledge, this is the first reported case of gastric mucormycosis in a cat. Previous literature includes a case of mucormycosis in a Persian cat affecting only the duodenum. In both the Persian cat and the cat described here, gastrointestinal mucormycosis disease progressed rapidly and was fatal.

Keywords: Gastric neoformation; fungal disease; mucormycosis; gastric infection

Accepted: 6 November 2024

Introduction

Mucormycosis is a fungal disease caused by genera of the order Mucorales, previously known as Zygomycota.¹ This order includes genera such as *Rhizopus*, *Absidia*, *Mucor*, *Cokeromyces* and *Saksenaea*.² Although the earliest reports of mucormycosis in animals date back to the late 1960s,³ reported cases are still relatively rare in the veterinary literature. In human medicine, mucormycosis is more frequently observed, and has been identified as an emerging and frequently fatal condition, particularly in diabetic and immunocompromised patients.⁴

This case report is the first, to the authors' knowledge, to document gastric mucormycosis caused by *Rhizopus microsporus* in a cat.

Case description

A 9-month-old spayed female Ragdoll cat was presented with acute persistent vomiting over the past 5 days. On one occasion, haematemesis was also noted. Furthermore,

reduced appetite and lethargy were observed. The cat had an unremarkable past history and had been on a raw rabbit-based biologically appropriate raw food (BARF) diet for the past 3 months. Clinical examination revealed moderate dehydration (7%), hyperthermia (39.9°C), pale mucous membranes with a capillary refill time of approximately 3 s and mild discomfort on abdominal palpation. The body condition score was 4/9 and body weight was 4.2 kg. Haematological and biochemical tests were within normal limits, and the cat tested negative for feline immunodeficiency virus (FIV) antibody and feline leukaemia virus (FeLV) antigens. Radiographic examination

¹Freelance Gruppo Endovet, Bergamo, Italy

²Freelance Gruppo Endovet, Cuneo, Italy

Corresponding author:

Emilio Mavilio DVM, Freelance Gruppo Endovet, Via Adeodato Bossi 13 A, Bergamo, 24123, Italy
Email: emilio.mavilio@virgilio.it



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons

Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

was unremarkable; however, abdominal ultrasonographic examination revealed multiple rounded neoformations at the pyloric antrum with increased echogenicity and mild mesenteric lymphadenomegaly. The rest of the abdominal cavity appeared normal.

Fluid therapy and omeprazole were initiated to stabilise the clinical condition. An endoscopic examination was carried out thereafter, which confirmed several neoformations at the pyloric antrum, ranging in size from 0.5 cm to 2 cm, with a smooth surface, sessile base and hard-elastic consistency (Figure 1). The duodenum appeared normal. During the procedure, cytological brushing (Olympus BC-201C-1006) and biopsies using 1.8 mm fenestrated forceps (Olympus FB-231 D) were performed.

Cytological analysis revealed mucosal cells in small clusters, mixed inflammatory cells with a predominance

of neutrophils and macrophages, and occasional large, non-septate hyphae with an irregular diameter and branched appearance. Pending histological results, fluid therapy and omeprazole were continued. Additionally, maropitant, sucralfate and antifungal therapy with ketoconazole at 20 mg/kg q12h was initiated. Treatment with amphotericin B was declined because of its excessive cost and concerns about side effects. In the days following the endoscopy, the cat's condition improved slightly, as characterised by partial restoration of appetite and reduced episodes of vomiting. However, hyperthermia and lethargy persisted.

Histological examination revealed severe diffuse necrotising and granulomatous gastritis with intralesional fungal hyphae, consistent with mucormycosis (Figure 2a). Biopsies of the gastric body and duodenum were normal (Figure 2b). PCR examination confirmed the presence of *Rhizopus microsporus* using ITS3 and ITS4 primers, with NL1 and NL4 sequenced by Basic Local Alignment Search Tool (<https://blast.ncbi.nlm.nih.gov>).

Because of the limited clinical response to ketoconazole and its poor efficacy in mucormycosis,⁵⁻⁷ surgical excision and amphotericin B therapy were proposed. However, the day before surgery, the cat became severely lethargic and showed marked hyperthermia (40.3°C) and dehydration (10%), as well as abdominal effusion. Abdominal ultrasonographic examination revealed signs of peritonitis, and cytology of abdominal fluid revealed septic neutrophilic inflammation with phagocytosis of both cocci and rods, but no fungal elements were detected in the exudate. No cultures or additional PCR tests were performed. Given the cat's critical condition, the owner elected euthanasia.

Post-mortem examination confirmed septic peritonitis as a result of perforation of the gastric wall at one of

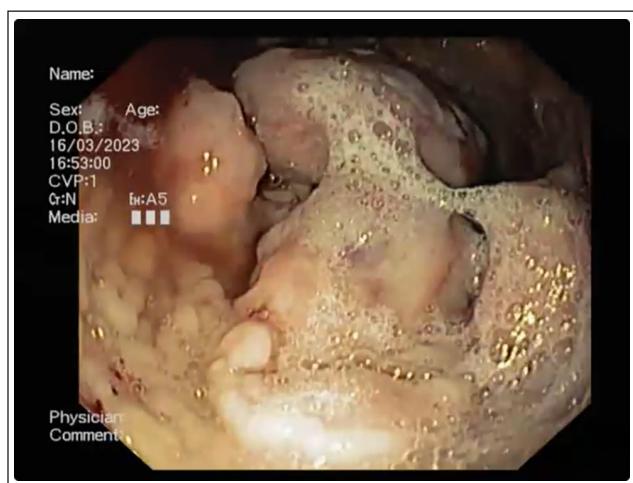


Figure 1 Gastric neoformations seen on endoscopy

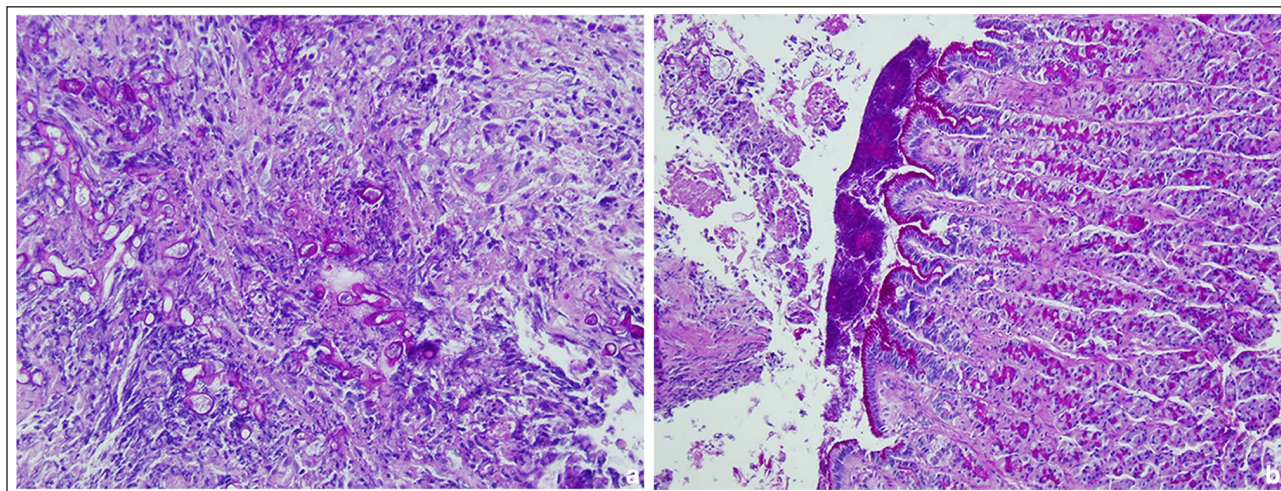


Figure 2 Histology of gastric biopsies stained with haematoxylin and eosin showing inflammatory lesions secondary to the presence of *Rhizopus microsporus*

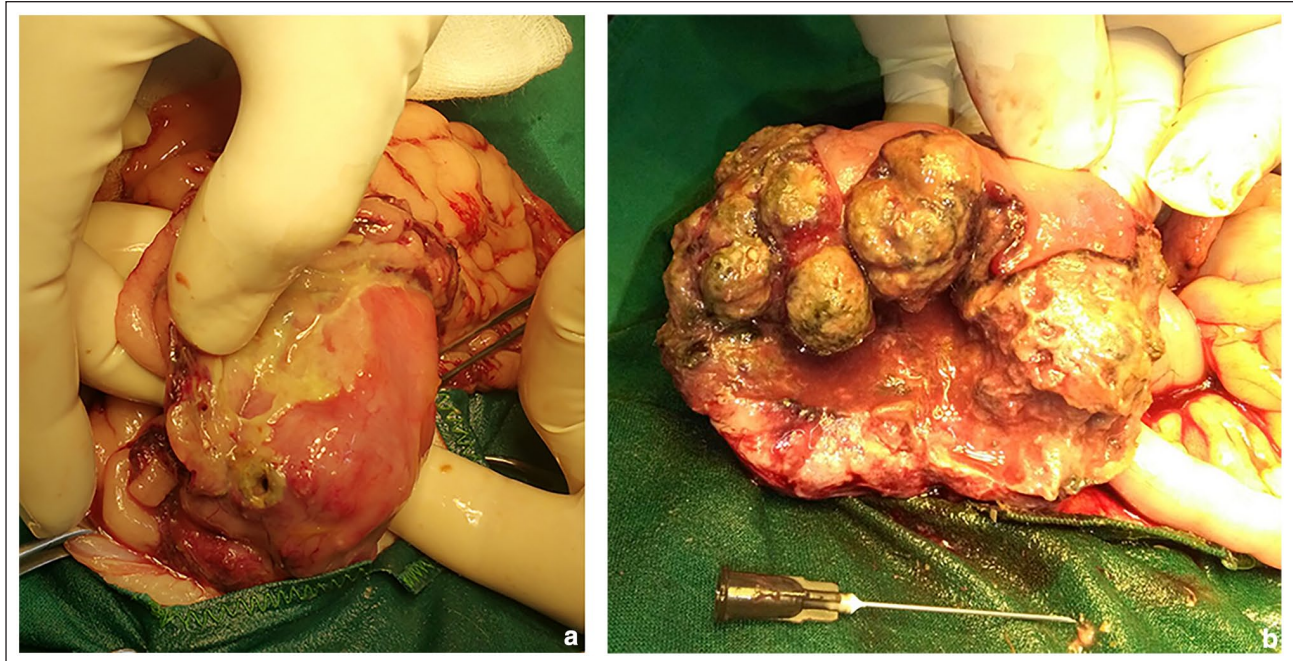


Figure 3 Stomach as seen on necropsy. It is evident that there is perforation of the gastric wall and fungal granulomas

the neoformations in the pyloric antrum (Figure 3). Histological examination of the stomach, duodenum, ileum, colon, spleen, liver, kidney and lung was performed; however, the presence of mucormycosis was confirmed only in the gastric biopsies.

Discussion

Mucormycosis is a disease caused by opportunistic fungi that are found in soil, decaying materials and food.⁸ In the veterinary literature, systemic forms have been reported in horses⁹ and cattle,¹⁰ as well as dogs.¹¹ In cats, the disease has been reported in various organs, including the skin, brain, nasal and duodenal areas.^{12–14} Gastrointestinal mucormycosis, though rare in both human and veterinary medicine, presents with high mortality rates, reaching up to 85% even with early diagnosis in humans.^{7,8,15} Recent increases in cases of gastrointestinal mucormycosis in humans suggest the emergence of more virulent fungal strains.¹⁶ In humans, the stomach is the most commonly affected site, followed by the colon, ileum, duodenum and jejunum.^{4,17} Notably, gastric mucormycosis has not been documented in veterinary cases. The current case aligns with the age of onset described in the only other case of duodenal mucormycosis in a cat: 9 months in the present case compared with 7 months in the previous report.¹⁴ By contrast, humans typically develop this disease at a later age, though cases in adolescents have been reported.¹⁸

In humans, gastrointestinal mucormycosis is often linked to the ingestion of contaminated food, such as

fermented products or herbal remedies.⁴ The current patient had been on a BARF diet, including raw rabbit with bones, in the 3 months preceding the onset of clinical signs. Given that the patient was an indoor cat, accidental ingestion of contaminated soil or grass seems unlikely. We speculated that the pathogen entered via the food.

In humans, gastrointestinal mucormycosis is more common in immunocompromised individuals,^{8,16} with uncontrolled diabetes mellitus, solid organ or stem cell transplantation, haematological malignancies and major trauma as the first causes.¹⁹ Cases have also occurred in patients without evident immunodepression.¹⁶ The present patient, similar to others described in feline and canine studies,^{13,14} showed no signs of immunodepression; serology for FIV and FeLV was negative, and the cat was in good health before presentation. Other fungal diseases, such as aspergillosis, also do not necessarily involve systemic immunodepression as a predisposing factor. It is hypothesised that individual susceptibilities and environmental conditions contribute to the development of mycosis.²⁰

In human medicine, mucormycosis progresses through stages: colonisation, infection and vascular invasion, potentially leading to systemic dissemination and septic peritonitis.²¹ Gastric wall perforation and subsequent septic peritonitis are reported complications.^{18,22,23} The current patient experienced gastric wall perforation about 2.5 weeks after the onset of fever, which coincides with human case reports.^{5,23} This raises the suspicion

that mucormycosis may be underdiagnosed, particularly in fatal septic peritonitis where the primary diagnosis remains unclear.²⁴ The present patient had a single episode of haematemesis, which resolved with symptomatic treatment, unlike the severe bleeding often reported in human cases.

Initial haemato-biochemical examinations were non-specific, although lymphocytosis and anaemia developed following peritonitis. Although these changes are consistent with mucormycosis in humans, lymphocytosis could also be related to septic peritonitis. Abdominal ultrasonographic examination revealed multiple intragastric neoplasms, a finding also seen in humans but less commonly than circumferential thickening or ulceration.¹⁴ Cytological examination of ascites did not reveal fungal elements; however, we did not perform culture or PCR on the effusion. It is possible that cytology alone is unlikely to detect mucormycosis in effusion, suggesting it may be underdiagnosed as a primary cause of septic peritonitis. Endoscopic findings of multiple round lesions in the stomach of a young cat are unusual, with differential diagnoses including neoplasms, mycotic and parasitic granulomas. Cylospirouria is rare,²⁵ and phytiosis has not been described in European cats;²⁶ therefore, mucormycosis should be considered in the differential diagnoses of intragastric neoplasms. Confirmation, as demonstrated in this case, requires endoscopic examination along with cytological and histological analysis.

Histological diagnosis is often performed by laparotomy in humans, and cytological examination by brush was diagnostic in the present case. This method provides rapid results, but histological confirmation, including periodic acid–Schiff staining and fungal typing by culture or PCR, remains essential. Despite advances, only 25% of human patients achieve an antemortem diagnosis.¹⁶

Veterinary literature offers limited information on treatment for mucormycosis. In one duodenal case, diagnosis was achieved post mortem with no attempted therapy beyond surgical excision.¹⁴ In our case, although treatment led to a modest improvement in the clinical condition, the decision to avoid more aggressive antifungal options, such as liposomal amphotericin B, was influenced by economic constraints. In human medicine, prompt and aggressive treatment is emphasised, which includes addressing predisposing factors, performing surgical debridement and administering antifungal therapy.¹⁶

Conclusions

Although mucormycosis is infrequent and likely underdiagnosed, this study highlights the importance of considering it in the differential diagnosis of septic peritonitis in young cats. Owing to the high mortality associated with this disease, prompt surgical intervention is likely to be crucial for improving outcomes. Early and accurate

diagnosis, followed by timely surgical treatment, may significantly impact the prognosis of mucormycosis in feline patients.

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognised high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work involved the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS Open Reports*. Although not required, where ethical approval was still obtained, it is stated in the manuscript.

Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental animals, including cadavers, tissues and samples) for all procedure(s) undertaken (prospective or retrospective studies). For any animals or people individually identifiable within this publication, informed consent (verbal or written) for their use in the publication was obtained from the people involved.

ORCID ID Emilio Mavilio  <https://orcid.org/0009-0002-0630-2889>

References

- Morrissey CO, Kim HY, Garnham K, et al. **Mucorales: a systematic review to inform the World Health Organization priority list of fungal pathogens.** *Med Mycol* 2024; 62. DOI: 10.1093/mmy/myad130.
- Grooters AM and Foil CS. Miscellaneous fungal infections. In: Greene CE (ed). *Infectious disease of the dog and cat*. Philadelphia, PA: WB Saunders, 2012, pp 675–688.
- König H, Nicolet J, Lindt S, et al. **Some mucormycoses of cattle, swine, cat, deer, and the flamingo.** *Schweiz Arch Tierheilkd* 1967; 109: 260–288.
- Petrikos G, Skiada A, Lortholary O, et al. **Epidemiology and clinical manifestation of mucormycosis.** *Clin Infect Dis* 2012; 54: 523–534.
- Sun M, Hou X, Wang X, et al. **Gastrointestinal mucormycosis of the jejunum in an immunocompetent patient.** *Medicine* 2017; 96. DOI: 10.1097/MD.00000000000006360.
- Anderson A, McManus D, Perreault S, et al. **Combination liposomal amphotericin B, posaconazole and oral amphotericin B for treatment of gastrointestinal Mucorales in an immunocompromised patient.** *Med Mycol Case Rep* 2017; 17:11–13.
- Kruger AJ, Umodi RM, Yearsley M, et al. **Development of mucormycosis colitis during prolonged hospitalization.** *ACG Case Rep J* 2017; 4. DOI: 10.14309/crj.2017.56.

- 8 Meteussin D, Telisinghe PU, Chong PL, et al. **Gastrointestinal: gastric mucormycosis.** *J Gastroenterol Hepatol* 2017; 32: 1537. DOI: 10.1111/jgh.13661.
- 9 Thirion-Delalande C, Guillot J, Jensen HE, et al. **Disseminated acute concomitant aspergillosis and mucormycosis in a pony.** *J Vet Med A Physiol Pathol Clin Med* 2005; 52: 121–124.
- 10 Schonmann M, Thoma R and Braun U. **A case of acute disseminates mucor encephalitis in a heifer.** *Schweiz Arch Tierheilkd* 1997; 139: 490–494.
- 11 Alves RC, Ferreira JS, Maia LA, et al. **Systemic and gastrohepatic mucormycosis in dogs.** *J Comp Pathol* 2020; 175: 90–94.
- 12 Ravisse P, Formentin H, Destombes P, et al. **Verebral mucormycosis in the cat caused by *Mucor pusillus*.** *Sabouraudia* 1978; 16: 291–298.
- 13 Wray JD, Sparkes AH and Johnson EM. **Infection of the subcutis of the nose in a cat caused by *Mucor* species: successful treatment using posaconazole.** *J Feline Med Surg* 2008; 10: 523–527.
- 14 Cunha SCS, Aguero C, Damico CB, et al. **Duodenal perforation caused by *Rhizomucor* species in a cat.** *J Feline Med Surg* 2011; 13: 205–207.
- 15 Choi HL, Shin YM, Lee KM, et al. **Bowel infarction due to intestinal mucormycosis in an immunocompetent patient.** *J Korean Surg Soc* 2012; 83: 325–329.
- 16 Mungazi SG, Zambuko B, Muchuweti D, et al. **Fatal haemorrhagic duodenal mucormycosis in a non-immunocompromised host: a case report.** *Med Mycol Case Rep* 2017; 17: 1–3.
- 17 Spellberg B. **Gastrointestinal mucormycosis: an evolving disease.** *Gastroenterol Hepatol* 2012; 8: 140–142.
- 18 Quaraishi AHM, Peshattiwar A, Umare G, et al. **Perforation peritonitis secondary to intestinal mucormycosis in a boy with type I diabetes mellitus.** *J Indian Assoc Pediatr Surg* 2020; 25: 118–120.
- 19 Naqvi HA, Nadeem Yousaf M, Chaudhary FS, et al. **Gastric mucormycosis: an infection of fungal invasion into the gastric mucosa in immunocompromised patients.** *Case Rep Gastrointest Med* 2020; 16. DOI: 10.1155/2020/8876125.
- 20 Mercier E, Peters IR, Farnir F, et al. **Assessment of Toll-like receptor 2, 4 and 9 SNP genotypes in canine sino-nasal aspergillosis.** *BMC Vet Res* 2014; 10: 187. DOI: 10.1186/s12917-014-0187-6.
- 21 Parker VJ, Jergens AE, Whitley EM, et al. **Isolation of *Cokeromyces recurvatus* from the gastrointestinal tract in a dog with protein-losing enteropathy.** *J Vet Diag Invest* 2011; 5: 1014–1016.
- 22 Roden MM, Zaoutis TE, Buchanan WL, et al. **Epidemiology and outcome of zygomycosis: a review of 929 reported cases.** *Clin Infect Dis* 2005; 41: 634–653.
- 23 Poyuran R, Dharan BS, Sandhyamani S, et al. **Mucormycosis-induced ileocecal perforation: a case report and review of literature.** *J Postgrad Med* 2020; 66: 48–50.
- 24 Scotti KM, Koenigshof A, Sri-Jayantha LSH, et al. **Prognostic indicators in cats with septic peritonitis (2002–2015): 83 cases.** *J Vet Emerg Crit Care* 2019; 29: 647–652.
- 25 Ibba F, Lepri E, Veronesi F, et al. **Gastric cylicospiruriosis in a domestic cat from Italy.** *J Feline Med Surg* 2014; 16: 522–526.
- 26 Mendoza L and Vilela R. **Anomalous fungal and fungal-like infections: lacaziosis, pythiosis, and rhinosporidiosis in clinical mycology.** 2nd ed. Elsevier BV, 2009, pp 403–415.