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REVIEW ARTICLE

# Mycotic aneurysm in a turtle hunter: brief review and a case report

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*Salmonella*-associated mycotic aneurysm is a rare, but dreaded, complication of salmonellosis. Immunocompromised and elderly populations are more susceptible to develop this extra-intestinal complication. *Salmonella* is spread via fecal–oral and vehicle-borne routes. Reptiles, especially small pet turtles, have been linked with an increased risk of *Salmonella* infection. Diagnosis of mycotic aneurysm is a challenge due to atypical presentations. Recently, widespread use of CT scan imaging to evaluate for unexplained abdominal pain and sepsis has led to early identification of mycotic aneurysms. Antibiotic therapy and surgical intervention are the cornerstones of management. Open surgery has been the gold standard of treatment but is associated with increased morbidity and mortality. A relatively new alternative to open surgery is endovascular aneurysm repair (EVAR). It is comparatively less invasive and is associated with reduced early morbidity and mortality in the setting of mycotic aneurysm. However, there is a risk of late infection. Here, we present a patient with *Salmonella* mycotic aneurysm initially treated conservatively with antibiotic therapy who later underwent successful interval EVAR with no complications to date. Also included is a brief review of *Salmonella*-associated mycotic aneurysms.

Keywords: Salmonella; *mycotic aneurysm*; *review*

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Mycotic abdominal aneurysm is a misnomer. It involves arterial wall degeneration by either bacterial or fungal infection, which eventually leads to aneurysm development (1). Its incidence is 0.65–4% of all aortic aneurysms, higher in East Asia compared to Western countries (2–5). In Western countries, *Staphylococcus aureus*, *Salmonella*, and *Pseudomonas aeruginosa* are the most common organisms known to cause this complication after bacteremia or hematogenous spread (5–7).

Among the mycotic aneurysms, *Salmonella*-associated aneurysms are more lethal with a rapid progression of size and eventually early rupture (8–11). It is a rare but dreaded complication of *Salmonella* infection. Compared to *Staphylococcus* and *Pseudomonas*, *Salmonella* would be the only organism causing mycotic aneurysm from a food-borne source. Here we present a patient with *Salmonella* mycotic aneurysm initially treated conservatively with antibiotic therapy who later underwent successful interval endovascular aneurysm repair (EVAR) with no complications to date. Also included is a brief review of *Salmonella*-associated mycotic aneurysms.

## Case

A 64-year-old male with past medical history of hypertension, hyperlipidemia, and peripheral artery disease with left carotid endarterectomy that was done 8 years ago, who was treated for *Salmonella* enteritis 4 months ago with ciprofloxacin 500 mg tablet twice daily for 10 days, presented with complains of nausea, vomiting, and abdominal pain. He had experienced these symptoms on and off since he was treated for enteritis, but worsened prior to admission. On examination, he had a temperature of 103.5°F; heart rate, 87 beats/min; blood pressure, 133/85 mm Hg; and oxygen saturation 97% on room air. There was epigastric tenderness without guarding or rigidity. Bowel sounds were normal. Examination of the other systems was unremarkable. Laboratory workup was normal except for a white cell count of 14,600/mcl and hemoglobin of 11.2 g/dl. CT scan of the abdomen with intravenous (IV) contrast that was done to evaluate for abscess showed a fusiform 3.4-cm infrarenal, abdominal, aortic aneurysm along with an adjacent 2.1 × 2.1 × 2.7-cm mycotic aneurysm (Figs. 1 and 2). He was stabilized in the hospital with IV meropenem and IV fluids. Subsequently, his blood





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cultures grew *Salmonella braenderup*. After a discussion with vascular surgery team regarding the risk benefits of EVAR versus open surgery, the patient opted for an interval endoluminal graft placement after completion of antibiotic therapy. After a week of IV antibiotics, repeat CT angiogram of the abdomen was done. It confirmed that the fusiform aneurysm was stable at the same size. He was discharged home with 6 weeks of ceftriaxone and advised to follow-up with infectious disease and vascular surgery for endoluminal graft placement. He successfully underwent interval EVAR and was doing well until 18 months after EVAR without any postoperative infectious complications (Figs. 3 and 4). The patient had a passion for hunting turtles and reported eating them cooked almost once every 2–3 months for the past 15 years. He was advised to avoid contact with turtles hereafter.

## Discussion

The Salmonellae are a heterogeneous group of bacteria in the genus *Salmonella* of the family Enterobacteriaceae. The Centers for Disease Control and Prevention (CDC) currently recognizes two species: *Salmonella enterica* (6 subspecies) and *Salmonella bongori* (1 subspecies). *Salmonella* are usually known to cause gastroenteritis, which rarely requires antibiotic therapy. Immunocompromised and elderly population are prone to develop extra-intestinal complications, the most feared being infected aneurysms of the abdominal aorta (12–19). *Salmonella typhimurium* (serogroup B), *Salmonella enteritidis* (serogroup D), and *Salmonella choleraesuis* (serogroup C) are the common serotypes associated with mycotic abdominal aneurysm (20, 21), *S. enteritidis* is more common in Europe compared to East Asia where non-typhoidal *Salmonella* is more common (10, 22–26).

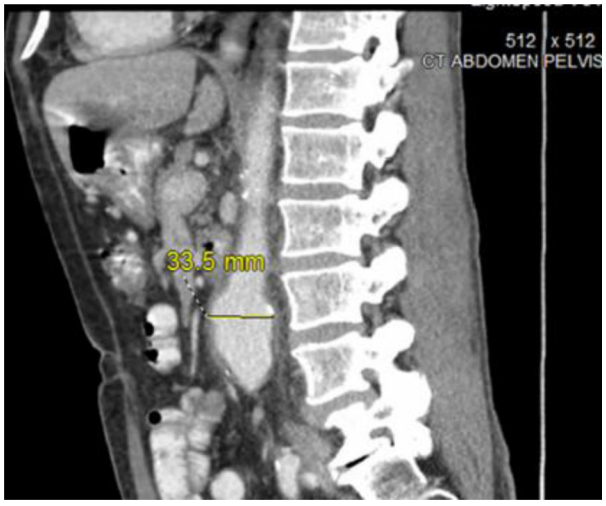


*Fig. 2.* CT angiogram of abdomen and pelvis – sagittal section showing the mycotic aneurysm.

*Salmonella* has a predisposition to attach to vascular endothelium, more so in atherosclerotic blood vessels (1). However, the exact mechanism and pathogenesis of *Salmonella* causing the mycotic abdominal aneurysm is still unclear (6). Recurrent and latent infections are possible from *Salmonella* due to mechanisms that promote intracellular survival (27). Mode of transmission of *Salmonella* is fecal–oral and vehicle-borne. Infection may result from ingesting water or food that has been contaminated with animal or human feces, or from direct exposure to the same (28). Mycotic aneurysms are a diagnostic challenge due to the wide array of uncommon presenting symptoms. However, some of the common presenting symptoms are fever, pain, shock, and leukocytosis (6). Widespread use of CT scan to evaluate for

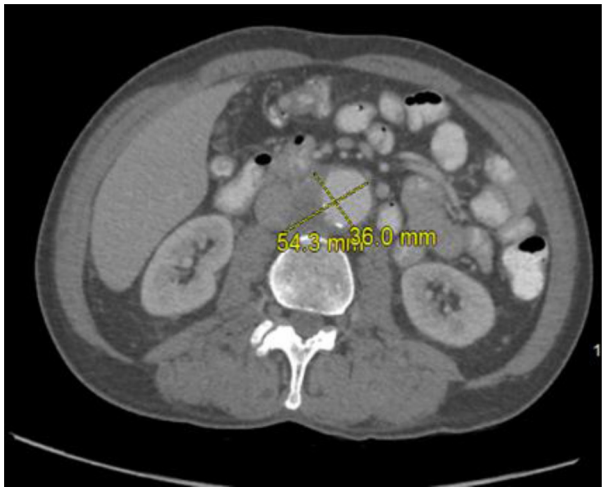


*Fig. 1.* CT angiogram of abdomen and pelvis – transverse section showing the mycotic aneurysm.

*Fig. 3.* CT angiogram of abdomen and pelvis – status post-EVAR with successful exclusion of the mycotic aneurysm.


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*Fig. 4.* CT angiogram of abdomen and pelvis (coronal view) – status post-EVAR with aorto-bi-femoral graft.

unexplained abdominal symptoms and sepsis has led to the early identification of mycotic abdominal aneurysm (6).

The Food and Drug Administration (FDA) prohibits the selling of turtles with a shell under 4 inches in length in an effort to prevent contact with turtles carrying the *Salmonella* bacteria. The CDC recommends that children, pregnant women, and persons with compromised immune systems avoid contact with reptiles to prevent contact with the *Salmonella* bacteria (29). Small pet turtles are of particular concern because children are more prone to handling them without washing their hands after, and even put the turtles in their mouths (29). Infectious disease specialists estimate that banning small turtles as pets prevents 100,000 *Salmonella* infections in children each year in the United States (29).

Antibiotic therapy is one of the cornerstones of management. There is uncertainty regarding the duration of antibiotics. It is a popular option to treat with at least 6 weeks of oral or parenteral antibiotics (1, 30). However, recent studies have shown that most recurrent infections occurred in the first 6–12 months after the procedure and the majority of the fatal infections and sepsis-related complications developed after discontinuing the antibiotics (1). These finding are suggestive of a potential benefit from long-term antibiotic therapy for 6 months to 1 year, or lifelong based on a case-by-case basis. Positive blood cultures for *Salmonella* during the initial postoperative period have a favorable outcome compared to non-*Salmonella*-positive blood cultures. Antibiotics directed toward *Salmonella* would yield a favorable outcome in patients with *Salmonella* infection. The same antibiotics would be less beneficial in patients who have a non-*Salmonella* infection (1, 10, 31–33).

Open surgery (debridement and surgical resection of the infected aorta and the surrounding tissues, the use of body tissue to cover the infected field, and either an extra-anatomic bypass or *in situ* interposition graft) followed by long-term antibiotic therapy has been the gold standard treatment but is associated with increased mortality and morbidity (1, 9, 10, 23, 32, 34–38). It has a short-term mortality of 20–40% although there is not sufficient data to comment on long-term outcomes (10, 23, 34–38). Anatomical position of the aneurysm sometimes makes open conventional surgery a less preferred option (1, 9).

EVAR is relatively a new alternative to the open surgery. It is comparatively less invasive and is associated with reduced early morbidity and mortality. It has the potential to become a popular alternative to open conventional surgical management, either as a permanent management option, or as a temporary bridge to stabilize the patient prior to open surgery. Insertion of a graft in acute infection prior to completing a course of antibiotics is controversial. Hence, interval EVAR (after a full course of antibiotic therapy) might help prevent late infection complications. However, in EVAR, there is a potential *nidus* for a late infection of the graft and sepsis. A recent retrospective study done by Sorelius et al. (1) analyzed that EVAR is a feasible and durable treatment option for patients with mycotic aneurysms. Post-EVAR, their study showed a 1-month survival of 91% and a120-month survival of 41%; however, only 19% deaths were due to infection. Non-*Salmonella*-positive blood cultures were associated with increased mortality from late infection (1). In mycotic abdominal aneurysm patients who do not pursue either surgical or endovascular treatment, studies have shown up to a 75% mortality rate from complications related to mycotic aortic aneurysm(6). There is a possibility of selection bias in the study done by Huang et al. (6). However, details of the indications leading up to an open surgery versus EVAR were not mentioned.

Based on this case report, it might be appropriate to mention that patients with vascular disease should be discouraged from hunting and handling turtles, for the fear of contracting *Salmonella* and then the risk of mycotic aortic aneurysm. Based on the review of literature, in a patient with Salmonellosis having abdominal pain, especially in patients with risk factors such as elderly age, atherosclerosis, and immunosuppressed status, a CT scan of the abdomen should be done to detect a possible mycotic aneurysm (12). CT is excellent in preoperative and postoperative evaluation of aneurysms and their potential complications (39).

Clinical significance:

1. Have a low threshold to get a CT scan of the abdomen in Salmonellosis patients with risk factors and abdominal symptoms.
2. In *Salmonella* mycotic abdominal aneurysm, there could be potential benefit from long-term antibiotic therapy for 6 months to 1 year or lifelong.

3. EVAR has the potential to become a popular alternative to open conventional surgical management of mycotic abdominal aneurysm as late infections are a major complication of the latter.

## Authors' contributions

All authors had access to the data and a role in writing the manuscript.

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None of the authors have a conflict of interest.

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