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CASE SERIES

Salmonella Mesenteric Lymphadenitis Causing Septic Peritonitis in Two Dogs

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Abstract: This report describes two cases of *Salmonella* mesenteric lymphadenitis leading to septic peritonitis in two young dogs. The cases were similar in presentation, diagnosis, treatment, and length of hospitalization. Both cases presented with clinical signs of vomiting, abdominal pain, and fever and were treated successfully via surgical debridement, omentalization, and antibiotic therapy. Both cases grew multi-drug resistant *Salmonella* spp. with resistance to ampicillin sulbactam, which is a common empiric antibiotic choice for cases of canine septic peritonitis. In both cases, the source of *Salmonella* is proposed to be the raw diet that preceded the septic peritonitis diagnosis. While *Salmonella* mesenteric lymphadenitis has been reported in humans and pigs, to the authors' knowledge, this is the first report of *Salmonella* mesenteric lymphadenitis in dogs.

Keywords: sepsis, abscess, raw, diet

Introduction

Mesenteric lymphadenitis is an inflammatory condition of the lymph nodes and has been documented in humans, pigs, and dogs.[1–7] The cause of mesenteric lymphadenitis in dogs can either have an immune-mediated[7] or infectious source.[5,8] While uncommon, the disease is important to be aware of as early diagnosis and treatment is critical for a favorable outcome. Bacterial agents that have been cultured in mesenteric lymphadenitis in dogs are *Escherichia coli, Serratia marcescens, Staphylococcus epidermidis, Staphylococcus aureus, Staphylococcus canis, and Prevotella* sp.[5] *Salmonella* has been documented as a cause of mesenteric lymphadenitis in humans[3,9] and pigs.[1,4] To the authors' knowledge, no cases of mesenteric lymphadenitis caused by *Salmonella* have yet been reported in dogs. *Salmonella* is a zoonotic agent that is often multi-drug resistant and can serve as an important source of nosocomial infection.[10–12] This case series describes two cases of canine septic peritonitis caused by *Salmonella* mesenteric lymphadenitis in which both cases were exposed to a raw diet.

Case Histories

The first case was an 11-month intact male Golden Retriever that presented with a 4-day history of progressive inappetence, lethargy, diarrhea, and vomiting, which began soon after an episode of dietary indiscretion. This dog's normal daily diet was a commercially available diet with raw ingredients.

Physical exam revealed depressed mentation, tacky mucous membranes, severe abdominal pain, and fever (41.5°C). Cardiopulmonary auscultation was within normal

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limits. Biochemistry results were within normal limits. Complete blood count (CBC) revealed a neutrophilic (25.3 x 10^3/uL, RI 4.0–8.1 x 10^3/uL) leukocytosis (27.2 x 10^3, RI 6.1–12 x 10^3/uL). Urinalysis was normal, and urine culture and tick-borne disease testing was negative.

Initial resuscitation and treatment included an intravenous (IV) bolus of lactated ringer's solution of 13 mL/kg followed by a rate of 5 mL/kg/hr, ampicillin sulbactam 30 mg/kg IV q8h, pantoprazole 1 mg/kg IV q12h, and maropitant 1 mg/kg IV q24h. Abdominal radiographs showed mild loss of serosal detail in the mid abdomen (Figure 1).

An abdominal ultrasound was performed which revealed all jejunal lymph nodes to be enlarged, hypoechoic, and containing cystic areas, surrounded with hyperechoic perinodal fat (Figure 2A and B). The pancreas was hypoechoic with hyperechoic peripancreatic fat, suggestive of pancreatitis (Figure 2C). Fine needle aspirate samples were taken from a jejunal lymph node, but were of very low cellularity and suggested reactive lymphoid hyperplasia and neutrophilic inflammation. Aerobic, anaerobic, and fungal cultures of the lymph node were submitted. Free peritoneal fluid was found and collected, and cytology was consistent with marked neutrophilic inflammation with bacterial sepsis (various intra- and extracellular rods).

Following the diagnosis of septic peritonitis, abdominal exploration revealed an approximately 12 cm firm fluid-filled ileocolic lymph node. The remaining jejunal lymph nodes appeared diffusely affected, but smaller. All other

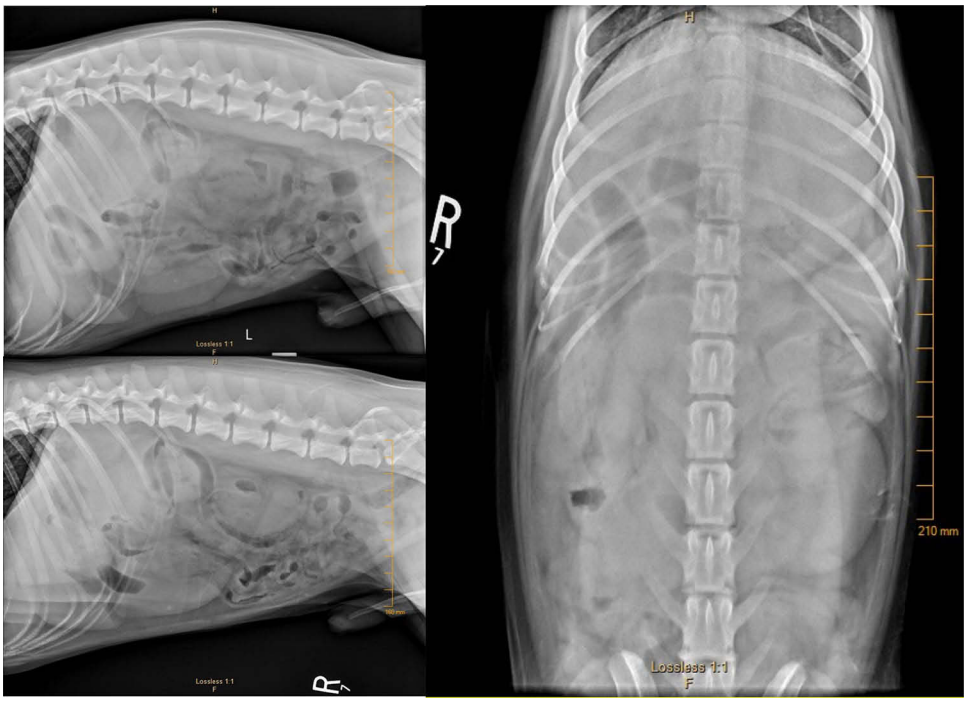

Figure 1 Abdominal radiographs with left, right, and ventrodorsal views depicting decreased serosal detail in the mid-abdomen. No mass effect was visualized.

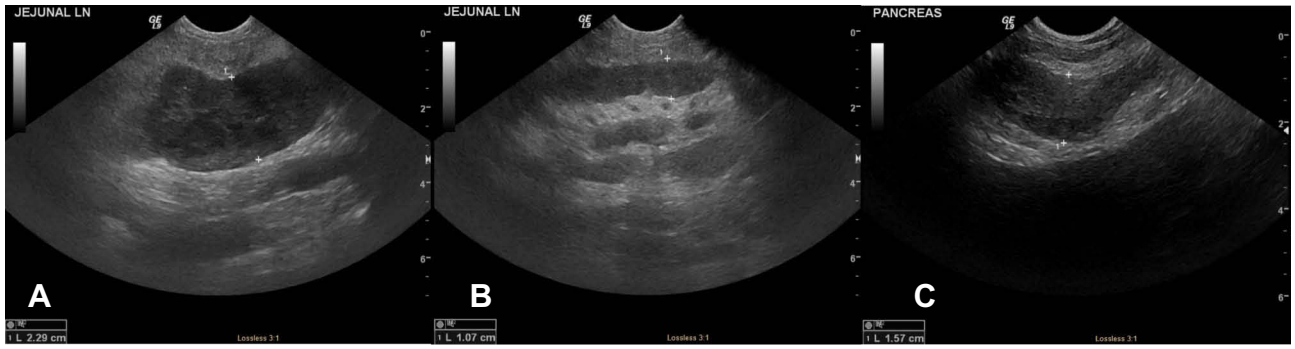

Figure 2 Ultrasound images of enlarged hypoechoic jejunal lymph nodes (**A** and **B**) and hypoechoic pancreas, suggesting pancreatitis (**C**).

organs appeared grossly normal. A lymph node biopsy sample was taken for histopathology and tissue culture was collected. The lymph node was lanced and lavaged, then omentalization was performed by placing the greater omentum into the lymph node and secured in place surgically. The abdomen was lavaged and a closed suction drain was placed.

The patient recovered well over the next 3 days. On Day 4, culture results returned multi-drug resistant *Salmonella* (see Table 1) and antibiotic regimen was switched to cefpodoxime 10 mg/kg PO q24h for 1 week. On Day 5 the drain was pulled and patient was discharged.

Lymph node histopathology revealed neutrophilic necrotizing steatitis, no infectious organisms were seen. Aerobic tissue cultures of the ileocolic lymph node revealed *Salmonella* species. Anaerobic and fungal cultures were negative.

Patient was rechecked on Day 11 and doing well, and was still alive after follow up 1 year later with no reported chronic diseases.

The second case was a 7-month intact female German Shepherd Dog that was presented on day 1 for progressive lethargy, anorexia, and vomiting over the last 4 days, which began the day after eating a wild bird. This dog's normal daily diet was a commercially available dry food. Pertinent physical exam findings included depressed mentation, marked ptyalism, fever (41.6°C), mild tachycardia, and a painful abdomen.

Table 1 Case #1 *Salmonella* Species Susceptibility Results

Antibiotic	MIC	Interpretation
Amikacin	8	R
Amoxicillin/Clavulanate	1/0.5	R
Ampicillin	1	R
Cefazolin	2	R
Cefovecin	1	S
Cefpodoxime	≤1	S
Ceftazidime	≤4	S
Cephalexin	4	R
Chloramphenicol	8	S
Doxycycline	2	S
Enrofloxacin	≤0.12	S
Gentamicin	0.5	R
Marbofloxacin	≤0.12	S
Orbifloxacin	≤1	S
Piperacillin/Tazobactam	≤8/4	S
Pradofloxacin	>2	R
Trimethoprim/Sulfamethoxazole	≤0.5/9.5	S
Tetracycline	≤4	S

Note: Susceptibility results of tissue culture revealed multi-drug resistant *Salmonella* species.
Abbreviations: MIC, minimum inhibitory concentration; R, resistant; S, susceptible.

Initial diagnostics included a CBC, biochemistry panel, point-of-care ultrasound (POCUS), urinalysis, and abdominal radiographs. Pertinent biochemical abnormalities included mild hypoalbuminemia (2.7, RI 2.8–3.6 g/dL) and mild hyperglobulinemia (4.6, RI 2.3–3.7 g/dL). CBC revealed a neutrophilic (9.7 x 10^3, RI 4.0–8.1 x 10^3/uL), monocytic (1.7 x 10^3, RI 0.1–0.7 x10^3/uL) leukocytosis with toxic neutrophils on blood smear. Abdominal radiographs revealed generalized loss of serosal detail. The POCUS exam revealed possible mass cranial to urinary bladder and scant free fluid. Initial treatments included IV lactated ringers solution at 3 mL/kg/hr, hydromorphone 0.1 mg/kg IV, and ampicillin sulbactam 30 mg/kg IV q8h. An abdominocentesis and cytology was performed, which revealed neutrophilic and proteinaceous exudate with bacterial sepsis (mixed intracellular rods of different morphologies). The fluid was submitted for aerobic and anaerobic culture.

Following diagnosis of septic peritonitis, abdominal exploratory surgery revealed a large, continuous abscess from the area of the jejunal lymph nodes tracking to the colonic lymph nodes. Gastrointestinal tract appeared normal. Biopsies were taken of multiple abscessed lymph nodes for histopathology. Both the jejunal and colonic lymph node abscesses were thoroughly debrided, lavaged, and omentalized. A final abdominal explore was performed with no other abnormalities found. The abdomen was lavaged and a closed suction drain was placed.

At 8 hrs postoperatively, the patient was stable and eating, but remained febrile. Enrofloxacin 10 mg/kg IV q24h was added and fever resolved 12 hrs later. Patient was discharged on day 5 with oral enrofloxacin 10 mg/kg PO q24h for 14 days.

Aerobic culture of the abscess grew multi-drug resistant *Salmonella* species (see Table 2). Lymph node biopsy diagnosed reactive lymphoid hyperplasia with draining inflammation and hemorrhage. Biopsy of the mesentery revealed locally extensive pyogranulomatous cellulitis. In both histopathology samples, no infectious etiologies were found.

Patient presented 1 year later for a wellness exam and was doing well.

Discussion

Mesenteric lymphadenitis is theorized to result from diffuse gastrointestinal inflammatory diseases such as pancreatitis,

Table 2 Case #2 *Salmonella* Species Susceptibility Results

Antibiotic	MIC	Interpretation
Amikacin	≤4	R
Amoxicillin/Clavulanate	1/0.5	R
Ampicillin	1	R
Cefazolin	2	R
Cefovecin	1	S
Cefoxitin	≤2	R
Cefpodoxime	≤2	S
Ceftiofur	0.5	S
Cephalothin	≤2	R
Chloramphenicol	8	S
Doxycycline	≤2	S
Enrofloxacin	≤0.25	S
Gentamicin	≤1	R
Marbofloxacin	≤0.25	S
Trimethoprim/Sulfamethoxazole	≤0.5/9.5	S

Note: Susceptibility results of abdominal fluid revealed multi-drug resistant *Salmonella* species.
Abbreviations: MIC, minimum inhibitory concentration; R, resistant; S, susceptible.

gastroenteritis, or inflammatory bowel disease.[2,5,13,14] The responsible bacterial agents are theorized to either come from the skin or intestinal tract, and once in the gastrointestinal tract, small amounts migrate to the lymph nodes naturally to contribute to innate immunity.[15] In the presence of inflammatory intestinal disease, however, a large amount of bacteria can migrate into the lymph nodes or translocate into the bloodstream, leading to severe mesenteric lymphadenitis and sepsis.[5,6,16-18] Bacterial agents previously cultured in dogs with mesenteric lymphadenitis include *Escherichia coli, Bacteroides, Serratia marcescens, Staphylococcus epidermidis, Staphylococcus aureus, Staphylococcus canis, Staphylococcus pseudintermedius, and Prevotella* sp.[5,8]

While the condition is well described in humans, mesenteric lymphadenitis is rarely reported in dogs. In both humans and dogs, the most common clinical signs include fever and abdominal pain, and ultrasonography is the main method of diagnosis.[2,3,5,7] In humans, the condition is often treated medically, while surgery is recommended in the presence of an abscess or septic peritonitis.[2] In a retrospective study of 14 dogs, the majority of mesenteric lymphadenitis cases were treated surgically, with only a few treated medically. Of those treated medically, 75% experienced a relapse within 4 months of discharge and required continued antibiotic therapy, compared to no relapses in the surgical cases.[5] This observation suggests that conservative therapy is possible in animals, but surgery should be recommended in the presence of an abscess or septic peritonitis.

Salmonella enterica has been documented as a cause of mesenteric lymphadenitis in humans and pigs.[1,3,4] It is a gram-negative bacteria transmitted fecal-orally, with multiple serotypes that infect a wide variety of mammals, birds, and reptiles. These characteristics make *Salmonella* an important source of zoonotic and nosocomial infections. Additionally, multiple surveillance studies have found *Salmonella* is often resistant to commonly used antibiotics (ampicillin, cephalosporins, tetracyclines), with a high prevalence of multi-drug resistance, which may complicate empiric antibiotic treatment.[19,20]

Infections with *Salmonella enterica* are uncommon in dogs, with an overall prevalence of 1% to 36% reported in dogs, many of which are subclinical carriers.[16,21-25] While animals infected may not show clinical signs, they do serve as an infectious source, shedding the bacteria in their feces for up to 6 weeks, contributing to environmental contamination.[16] Puppies (less than 1 year of age) are more susceptible to infection and clinical illness compared to adults.[16,26] Important sources of salmonellosis in companion animals include raw diets,[22,27-30] pet reptiles in the household,[23] and ingestion of wild birds.[31] Raw pet foods have been surveyed worldwide for salmonellosis, with reported positive samples ranging from 7.1% to 21%.[27,28,32] This prevalence of *Salmonella* in raw food diets is significantly higher than commercial dry dog food products,[22,33] indicating raw food diets pose higher risk of *Salmonella* exposure to pet dogs. In a study evaluating the prevalence of *Salmonella* in 2422 dogs, it was found that *Salmonella*-positive dogs were significantly more likely to have consumed raw food.[21] Fecal shedding rates after ingesting a single raw meal diet have been reported significantly higher (30–44%) than those not fed raw diets.[22,34] Pet owners should understand the high risk of *Salmonella* contamination in commercial raw food diets with the consequential high fecal shedding rate of *Salmonella*.

In conclusion, while uncommon in dogs, mesenteric lymphadenitis should be on the differential list in dogs with acute vomiting, abdominal pain, and fever. Diagnosis can be made via ultrasonography or abdominal exploratory surgery if septic peritonitis is diagnosed via fluid analysis. Salmonellosis should be a differential for cases of mesenteric lymphadenitis, especially if the patient is young (less than 1 year of age) with a history of ingestion of raw diet or wild birds. As *Salmonella* is often resistant to commonly used antibiotics, appropriate broad-spectrum antibiotic therapy and surgical debridement should be initiated as soon as possible.

Ethics Statement

Treatment of the animals described in this case series followed best practice veterinary care guidelines, with written informed consent provided by their owners.

Disclosure

The authors report no conflicts of interest in this work.

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