PAPER

# Retrospective characterisation and outcome of canine idiopathic mesenteric purulent lymphadenitis and lymph node abscesses at a teaching hospital from 2005 to 2015

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**Background:** Idiopathic purulent mesenteric lymphadenitis or lymph node abscessation, even though rare in dogs, are important diseases in which rapid diagnosis and treatment is critical. This study aimed to characterise the typical features of these conditions in dogs.

**Material and Methods:** Archived records from 2005 to 2015 were retrospectively evaluated for the occurrence of idiopathic purulent mesenteric lymphadenitis or lymph node abscesses in dogs. History, physical and clinicopathological abnormalities, diagnostic tests performed, treatment and outcome were reviewed.

**Results:** A total of 14 cases with histopathologic and/or cytologic confirmation were identified. Typically, there were gastrointestinal signs including abdominal pain and elevated body temperature. Blood analysis revealed non-specific inflammatory changes including elevated C-reactive protein. Half of the bacterial cultures from lymph nodes showed growth of various bacteria. A primary cause was not identified in any case. Out of 14 cases, 10 cases underwent surgery and all dogs were discharged from the hospital. Three suffered from a relapse between 1 and 5 months after discharge but were successfully managed with antibiotics.

**Conclusion and Clinical Relevance:** Idiopathic purulent mesenteric lymphadenitis or lymph node abscessation are infrequent but clinically important diseases. Surgical, symptomatic and antibiotic treatment led to resolution of clinical signs in the evaluated cases. Thorough and standardised diagnostic workup and treatment of future cases are necessary to investigate possible pathogeneses and optimal therapeutic options. Outcome was favourable overall.

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## INTRODUCTION

Lymph node abscessation or purulent lymphadenitis limited to the intra-abdominal (mesenteric) lymph nodes have been rarely described in dogs, with most publications presenting single case reports or small case series (Macpherson 1992, Beaumont & Glauberg 1979, Campbell 2009). Intra-abdominal abscesses may occur in the pancreas spleen, liver, kidneys, ovaries and within the retroperitoneal space (Schwarz *et al.* 1998, Agut *et al.* 2004, Schulz *et al.* 2006, Anderson *et al.* 2008, Boza *et al.* 2010, Abdellatif *et al.* 2014). Reported aetiologies include urolithiasis and bacterial urinary tract infection (Agut *et al.* 2004, Lee *et al.* 2009), suspected ingested foreign bodies including migrating plant material (Campbell 2009, Marvel & Macphail 2013),

remnants of suture material or surgical gauze from previous surgical procedures (Ho-Jung *et al.* 2007, Boza *et al.* 2010, Rayner *et al.* 2010), traumatic injury to organs (Schulz *et al.* 2006), and organ metaplasia or ectopy (Tobleman & Sinnott 2014). The presence of diffuse inflammatory gastrointestinal (GI) disease (e.g. gastroenteritis, perforated foreign body, pancreatitis) with bacterial translocation, peritonitis or sepsis is frequently assumed in cases of diffuse intra-abdominal lymphadenitis or mesenteric lymph node abscessation but can be difficult to prove in individual cases (Beaumont & Glauberg 1979, Macpherson 1992, Schwarz *et al.* 1998). Bacterial species isolated from affected lymph nodes have included *Staphylococcus intermedius*, which typically colonises the skin and prompts speculation on the significance of this finding or the possible point of entry (Macpherson 1992, Lee *et al.* 2009, Abdellatif *et al.* 2014). Important differential diagnoses for lymphadenopathy or lymphadenitis in small animals are mycobacterial or *Bartonella species* infections (Pappalardo *et al.* 2000, Morales *et al.* 2007, Duncan *et al.* 2008, Tucker *et al.* 2014). However, such infections typically lead to generalised granulomatous or pyogranulomatous lymphadenitis in dogs (Saunders & Monroe 2006, Morales *et al.* 2007) and there is only a single case report of intra-abdominal infection with *Mycobacterium tuberculosis* in a dog (Engelmann *et al.* 2014).

Recently, anecdotal reports have suggested an increase in diagnosis of idiopathic mesenteric lymphadenitis/mesenteric lymph node abscessation (mLAd/mLAb) in dogs. Therefore, a retrospective analysis to identify these cases and describe typical features of history and physical examination, laboratory abnormalities, treatment and outcome was carried out. The aim was to identify possible common characteristics or pathomechanisms that might enable earlier identification and to describe treatment options.

## MATERIALS AND METHODS

Electronic case files from January 1, 2005 to December 31, 2015 of both the hospital's internal medicine and soft tissue surgery service databases were evaluated (Easyvet Clinical Data Management System, IFS Informationssysteme GmbH, Hannover, Germany). For this, the software's integrated search tool was used to perform so-called filtering of files for different search terms. These included "lymph node(s)" combined with "*abdom* and "*mesent*," respectively; and the search was conducted within either the surgical procedure report, final diagnosis, free-hand text or discharge report section of the patient files. A similar search was performed for the same hospital's clinical pathology service (central laboratory) database using the same search terms within the cytology or pathology report section of the files. From this initial list of cases, duplicates were removed manually. Patient files were excluded if the final diagnosis within either the patient's record or the cytology or histopathology report was not purulent or mixed lymphadenitis or lymph node abscess, and if the location of the respective lymph node(s) was not recorded as intra-abdominal or mesenteric, or if the medical record was incomplete (e.g. location of lymph node not specified, no final diagnosis made) and the diagnosis of mLAb/mLAd could not be confirmed retrospectively. Diagnosis was based on either cytologic and/or histologic lymph node examination.

## RESULTS

The initial search yielded a total of 4842 hits combined in all three databases. After removal of duplicates and cases with lymphadenitis/abscesses at locations other than mesenteric, 55 cases remained. Of those, 30 cases were excluded because no fine needle aspiration (FNA) or biopsy was performed, meaning that the aetiology of mesenteric lymphadenopathy remained unclear (enlarged lymph nodes with the suspicion of lymphadenitis were apparent on abdominal ultrasonography in all of those cases). An additional six cases were excluded, because, even though initial lymph node cytology was consistent with purulent or mixed lymphadenitis, histopathology revealed neoplasia or metastasis (n=1 of each: lymphoma, fibrosarcoma, carcinoma, histiocytic neoplasia) or reactive hyperplasia (n=2). Finally, in a total of five cases, acquired samples were either non-diagnostic (n=2) or another intra-abdominal aetiology was identified that was likely responsible for mLAd/mLAb (pancreatitis/pancreatic abscess n=2, purulent hepatitis n=1), hence these were also excluded. This left 14 cases of presumed idiopathic mLAd/mAb, which are described in detail below.

Signalment, treatment, follow-up and outcome are shown in Table 1. Median age at presentation was 41 months (range: 6 to 98 months) and median body weight was 19·9 kg (range: 4·5 to 36·2 kg). The male to female ratio was 1:1·8. The small Munsterlander breed seemed subjectively overrepresented compared to the normal hospital patient population, but numbers were too small to calculate a meaningful odds ratio. Main presenting complaints were frequently non-specific (inappetence n=9, elevated body temperature n=8, lethargy/weakness/exercise intolerance n=7, diffuse pain n=4) or related to the GI tract (diarrhoea n=6, vomiting n=5). Lameness, stiff gait and ataxia were reported in three dogs, and in two dogs observed pain was presumed to be of abdominal origin. Additional signs were collapse, polyuria/polydipsia, mastitis, adipsia, halitosis, swollen vulva, subcutaneous mass, and cough (each n=1). Findings on physical examination were variable, but included pain on abdominal palpation in all cases. The median rectal temperature was 39·2°C (range: 37·9 to 40·6°C), median heart rate 114 bpm (range: 78 to 138 bpm) and median breathing rate 36 breaths/min (range 28 to 66 breaths/min).

Clinicopathological data [complete blood count (CBC), serum biochemistry (BC)] from all dogs are shown in Table 2. In addition to standard BC (n=14), amylase and non-specific lipase activity were assessed in five dogs, canine pancreatic lipase (cPL) in four dogs (two had a normal semiquantitative bed-side test (SNAP® cPL™ Test, IDEXX laboratories (Vet Med Labor Germany), Ludwigsburg, Germany), two had quantitative assessment less than 200 pg/mL, Spec cPL® Test, IDEXX laboratories (Vet Med Labor Germany), Ludwigsburg, Germany). Fibrinogen, PT and aPTT were measured in five dogs each, and d-dimer

**Table 1. Signalment, pretreatment, type of treatment and outcome in 14 dogs with idiopathic mesenteric lymphadentitis/lymph node abscess**

| Dog ID | Breed | Gender | Age at time of presentation (months) | Diagnosis based on: cytology (C) histology (H) | Pretreatment | Treatment: surgical (S) conservative drug therapy (C) and antibiotics used | Length of hospitalisation/ follow-up (days) | Outcome |
|---|---|---|---|---|---|---|---|---|
| 1 | Coton de Tulear | Mc | 63 | C | potAmox, metamizole | C, potAmox | 10/16 | Alive |
| 2 | Small Munsterlander | F | 98 | H | Carprofen | S, potAmox | 10/35 | Alive |
| 3 | Poodle | F | 58 | C, H | Ampicillin, dexamethasone, scopolamine | S, potAmox, enrofloxacin | 7/104 | Alive |
| 4 | German wirehair pointer | M | 15 | C | Marbofloxacin, scopolamine, single-protein diet, metamizole | C, marbofloxacin | 5/447 | Alive |
| 5 | Fox terrier | M | 40 | C, H | None | S, potAmox | 8/971 | Alive |
| 6 | Mixed breed | Fs | 22 | C, H | Amoxicillin, doxycyclin, metamizole | S, potAmox, enrofloxacin | 8/166 | Alive, recurrence after 1 month, discharged again |
| 7 | Old English sheepdog | F | 47 | C, H | potAmox, enrofloxacin, metamizole, carbesia | S, potAmox, enrofloxacin, metronidazole, doxycyclin | 11/32 | Alive |
| 8 | Small Munsterlander | F | 14 | C, H | Penicillin-streptomycin, scopolamine | S, potAmox | 10/0 | Discharged, but euthanased for unknown reason 1 year later |
| 9 | Gordon Setter | M | 90 | C | None | C, potAmox | 1/ 14 | Alive |
| 10 | Border Collie | Fs | 93 | C | None | C, potAmox | 3/0 | Alive |
| 11 | Mixed breed | F | 24 | C, H | None | S, potAmox, enrofloxacin | 9/7 | Alive |
| 12 | Mixed breed | Fs | 41 | C, H | None | S, potAmox, enrofloxacin | 20/43 | Alive, recurrence after 5 months, discharged again |
| 13 | Mixed breed | F | 13 | C, H | Ciprofloxacin, metamizole | S, pradofloxacin, cephalexin | 26/0 | Alive |
| 14 | Small Munsterlander | M | 6 | C, H | Ampicillin, metamizole | S, Ampicillin, enrofloxacin, doxycyclin | 5/261 | Alive, recurrence after 3 months, discharged again |

**Table 2. Laboratory parameters in 14 dogs with presumed idiopathic mesenteric lymphadenitis/lymph node abscesses. Bold numbers indicate a mean outside the respective reference range**

| Parameter | Value (mean±sd) | Reference interval | Units | Number of patients (n/14) |
|---|---|---|---|---|
| WBC | **24·42** (±14·09) | 5·48 to 13·74 | 10e9/L | 14/14 |
| Neutrophils | **19·91** (±12·97) | 2·78 to 8·73 | 10e9/L | 14/14 |
| Lymphocytes | 2·37 (±1·04) | 0·72 to 4·71 | 10e9/L | 14/14 |
| Monocytes | 2·28 (±2·90) | 0·06 to 0·83 | 10e9/L | 14/14 |
| Eosinophils | 0·28 (±0·22) | <1·47 | 10e9/L | 14/14 |
| Basophils | 0·05 (±0·07) | < 0·11 | 10e9/L | 14/14 |
| LUC | **0·51** (±0·54) | < 0·04 | 10e9/L | 11/14 |
| Band neutrophils | **2·15** (±2·69) | < 0·5 | 10e9/L | 9/14 |
| RBC | 6·14 (±1·32) | 5·5 to 8·5 | 10e12/L | 14/14 |
| Hgb | 11·64 (±3·54) | 8·06 to 12·21 | mmol/L | 14/14 |
| HCT | 41·5 (±8·9) | 39 to 56 | % | 14/14 |
| Reticulocytes | 29·94 (±18·76) | < 60 | 10e9/L | 7/14 |
| RDW | **14·27** (±1·94) | 10·76 to 12·8 | % | 14/14 |
| MCV | 67·54 (±3·67) | 62·61 to 73·5 | fL | 14/14 |
| MCH | 1·62 (±0·19) | 1·35 to 1·62 | fmol/L | 14/14 |
| MCHC | **27·71** (±4·25) | 20·82 to 23·53 | g/dl | 14/14 |
| Plt | 273 (±130) | 150 to 500 | 10e9/L | 14/14 |
| Urea | 8·4 (±7·7) | 3·3 to 9·82 | mmol/L | 14/14 |
| Creatinine | 103 (±99) | 53 to 122 | µmol/L | 14/14 |
| Sodium | 145 (±3) | 141 to 146 | mmol/L | 14/14 |
| Chloride | 109 (±4) | 104 to 112 | mmol/L | 14/14 |
| Potassium | 3·8 (±0·5) | 3·35 to 4·37 | mmol/L | 14/14 |
| Ionized Calcium | 1·33 (±0·11) | 1·23 to 1·43 | mmol/L | 13/14 |
| Anorganic phosphorus | 1·59 (±0·81) | 0·79 to 2·1 | mmol/L | 13/14 |
| Ionised magnesium | 0·55 (±0·20) | 0·47 to 0·63 | mmol/L | 13/14 |
| Total protein | 65·5 (±6·0) | 55·3 to 69·84 | g/L | 14/14 |
| Albumin | **27·1** (±5·5) | 29·6 to 37·01 | g/L | 14/14 |
| Globulin | **38·5** (±7·0) | 22·9 to 35·6 | g/L | 14/14 |
| Glucose | 6·17 (±7·02) | 3·3 to 6·5 | mmol/L | 14/14 |
| Total bilirubin | **3·82** (±1·89) | 0 to 3·6 | µmol/L | 14/14 |
| Cholesterol | 6·28 (±1·90) | 3·3 to 8·6 | mmol/L | 14/14 |
| Triglycerides | 0·711 (±0·68) | 0·08 to 0·75 | mmol/L | 13/14 |
| ALP | **308** (±536) | <130 | U/L | 14/14 |
| ALT | 40 (±28) | <85 | U/L | 14/14 |
| GLDH | 2 (±1) | <9·9 | U/L | 13/14 |
| CK | **238** (±312) | <143 | U/L | 11/14 |
| Amylase | 787 (±277) | <1157 | U/L | 5/14 |
| Lipase | 67 (±61) | <300 | U/L | 4/14 |
| Fibrinogen | **4·11** (±1·79) | 1·21 to 3·03 | mmol/L | 5/14 |
| PT | 7·6 (±8·1) | 6·5 to 8·2 | seconds | 5/15 |
| aPTT | 11·3 (±12·3) | 9·9 to 14·2 | seconds | 5/15 |
| d-dimers | **0·4** (±0·27) | <0·1 | µg/dL | 3/14 |

concentrations in three (see Table 2). Thrombelastograms were performed in five dogs, four of which were normocoagulable, and one hypercoagulable (dog 7). C-reactive protein (CRP) serum levels were assessed in eight dogs and were elevated in all but one individual. Because CRP was measured using two different assays with separate reference intervals and sensitivities across the years, a more detailed comparison between dogs is difficult. Values with one assay (Gentian specific canine CRP Test (immunoturbidimetric), Scil Animal Care, Viernheim, Germany) were 0·1, 35·3, 41·3, 56, 60·8 and 73·5 mg/L (reference interval 0 to 13·33 mg/L), and 212 and 229·3 µg/L with the other (Randox CRP test, Randox Laboratories Ltd., Crumlin, UK) (reference interval 0 to 14·9 µg/L). Results from venous blood gas analysis were available on the day of admission for five dogs showing a mean pH of 7·35 (sd: 0·02), $HCO_3$ of 21·64 mmol/L (sd: 2·98 mmol/L), $pCO_2$ of 39·48 mmHg (sd: 3·55 mmHg), base excess of –3·4 (sd: 3·1), and a lactate of 2·22 mmol/L (sd: 1·27 mmol/L). Urinalysis was performed in 9 of 14 dogs (see Table 3), including bacterial urine culture in seven (all negative).

Additional diagnostic tests included thoracic (n=13) and abdominal (n=10) radiographs, abdominal ultrasound (n=14), and CT/MRI (head and spine n=2; abdomen n=1). Cerebrospinal fluid and multiple joint taps were performed in a total of four dogs. Other diagnostics included analysis of ascitic fluid (n=3; all septic exudates), bacterial culture from ascites (n=2, both negative), culture of swabs or biopsies from mesenteric lymph nodes/abscesses (n=6; three of which were negative, isolated organisms from the others included *Escherichia coli*, *Serratia marcescens*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus canis*, *Prevotella species*), joint fluid culture (n=1, negative), and faecal culture (n=1: *Enterobacter cloacae* +++, Proteus species ++, *Clostridium perfringens* +++). An attempt to identify acid-fast bacterial species by either culture or Ziehl-Neelsen staining of lymph node biopsies was only specifically mentioned in two cases

**Table 3. Urinalysis from 9/14 dogs with idiopathic mesenteric lymphadenitis/lymph node abscesses**

| Dog ID | USG (>1035) | pH (6·5 to 7·5) | Bilirubin (negative) | Blood/RBC (+) | Glucose (Negative) | Ketones (Negative) | Protein (Negative to positive) | Sediment (Negative) | UPC (<0·5) |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 1026 | 5 | ++ | +++ | Neg | Neg | +++ | >5/hpf RBC | 1·1 |
| 5 | 1020 | 7·5 | Neg | Neg | Neg | Neg | Neg | Neg | n.p. |
| 6 | 1038 | 5 | Neg | Neg | Neg | Neg | + | Neg | n.p. |
| 7 | 1042 | 7·5 | + | Neg | Neg | Neg | + | Neg | n.p. |
| 8 | >1050 | 5 | + | +++ | Neg | Neg | + | Scarce renal epithelia | n.p. |
| 10 | 1025 | 8 | n.p. | n.p. | n.p. | n.p. | n.p. | Neg | n.p. |
| 11 | 1018 | 7 | Neg | Neg | Neg | Neg | ++ | Neg | 0·4 |
| 12 | 1018 | 7 | + | +++ | Neg | Neg | +++ | >5/hpf WBC and RBC | n.p. |
| 14 | 1048 | 6·5 | Neg | Trace | Neg | Neg | ++ | >5/hpf WBC and RBC | 0·2 |

Hpf high-power field, n.p. not performed, Neg negative, RBC red blood cells, WBC white blood cells
Reference ranges are provided in brackets

(both negative). PCR for infectious organisms was not performed on any sample from the 14 dogs, and vector-borne diseases were only investigated in two dogs (one *Leishmania* species serology, one PCR for *Babesia* species).

Faecal parasitology (sedimentation/flotation and Giardia antigen) was performed in two dogs, which were both negative. Fine needle aspirates of distant sites included peripheral lymph nodes (n=1; normal lymph node/reactive hyperplasia) and subcutaneous masses (n=2; both lipomas).

Because no causative agent or underlying disease process was identified in any of the dogs, the tentative diagnosis of idiopathic mLAd/mLAb was made. In one dog, a possible association between the disease and the fact that the dam suffered from severe septic mastitis when the dog was a puppy (before being weaned) was postulated but a causal relationship was difficult to prove. An additional two dogs suffered from degenerative intervertebral disc disease (IVDD) simultaneously to the detection of mLAd/mLAb (neurolocalisation L7 to S1 in dog 1; C1 to C4 in dog 2), but again, a causal relationship seemed unlikely. There was no evidence of discospondylitis on CT/MRI in these dogs. Dog 2 underwent surgical treatment for IVDD (ventral slot C2/3) 4 days after surgical intervention for the mLAd/mLAb and recovered uneventfully from both procedures. This dog was well and normothermic 4 and 8 weeks after discharge. Dog 1 was managed conservatively for IVDD (kennel rest, analgesics) and also recovered well. Another dog (dog 5) developed fibrocartilaginous embolic disease 14 months after mLAd/mLAb was diagnosed, but again, a causal relationship seemed unlikely.

In another case (dog 4) balloon valvuloplasty for pulmonic stenosis had been performed a month before development of diarrhoea, hyperthermia and lethargy, and subsequent diagnosis of mLAd/mLAb. No valvular abnormalities consistent with endocarditis were detected on echocardiography at any stage. Follow-up physical examination and echocardiography 3 and 12 months after the initial valvuloplasty were also within normal limits.

Dog 13 had an exploratory laparotomy 2 months previously, during which remnant ovarian tissue was removed. The dog then developed lethargy, hyperthermia, diarrhoea with tenesmus and a palpable rectal mass when mLAd/mLAb was diagnosed (with *S. epidermidis*, *S. canis*, *streptococci*, two types of *E. coli* and *Prevotella species* isolated from the abdominal lymph nodes on two separate occasions) and was subsequently diagnosed with a leiomyoma dorsal to the rectum, which was successfully removed. This dog was hospitalised for a prolonged period of time because of septic peritonitis but eventually recovered. It was thought unlikely that previous surgery or the leiomyoma, which was well encapsulated and easy to remove, was responsible for mLAd/mLAb but a causal relationship cannot be fully excluded. Two and four weeks after discharge from the hospital, physical examination was within normal limits and abdominal ultrasound showed mild focal thickening of the rectal wall, which was interpreted as post-operative changes/scarring.

In the majority of dogs (n=10), surgical intervention with removal (n=4), biopsy (n=3) or debridement and omentalisation (n=3) of the affected mesenteric lymph nodes (or a combination of these procedures, n=1) was performed, whereas four received antibiotic and supportive treatment alone (see Table 1). Surgical findings were variable, but included generalised mild intra-abdominal lymphadenopathy in addition to the affected lymph node (n=8), generalised peritonitis (n=5), detection of an intra-abdominal mass without connection to a specific organ (n=4), abscessation of intra-abdominal lymph node(s) (n=4), small amounts of ascites (n=3), inflammation of the intestine, described as white generalised plaques on the serosal surface and bleedings (n=2), and changes of other intra-abdominal organs (spleen, liver, pancreas, n=4). The abnormal lymph nodes/masses themselves were of variable sizes, ranging from multifocal but small (approximately 2×1 cm) to around 6·5 cm diameter. Biopsies from other intra-abdominal organs were taken in the minority of cases: intestinal full thickness biopsies revealed mild lymphoplasmacytic (dog 5) and moderate eosinophilic enteritis (dog 14), and hepatic biopsies showed unspecific changes (mild reactive/mixed cellular hepatitis, mild fibrosis, mild cholestasis and congestion) in two cases (dogs 7 and 12).

Dogs received a variety of supportive treatments and drugs either as an addition to surgery or as a sole therapy, and are shown in Table 4. All dogs were discharged alive, but follow-up times

**Table 4. Medical treatments administered to 14 dogs with presumed idiopathic mesenterial lymphadenitis/lymph node abscesses**

| Drug class | Active ingredient | Number of dogs |
|---|---|---|
| Antimicrobials | Amoxicillin/clavulanate | 11 |
| | Enrofloxacin | 6 |
| | Doxycyclin | 2 |
| | Marbofloxacin | 1 |
| | Ampicillin | 1 |
| | Verafloxacin | 1 |
| | Cephalexin | 1 |
| | Metronidazole | 1 |
| Anti-inflammatories | Metamizole | 4 |
| | Robinacoxib | 1 |
| Analgesics | Tramadol | 4 |
| | Fentanyl | 1 |
| | Buprenorphin | 1 |
| | Tetrazepam | 1 |
| Gastroprotectants | Omeprazol | 4 |
| | Pantoprazol | 4 |
| | Sucralfate | 3 |
| Antiemetics | Maropitant | 3 |
| | Metoclopramide | 3 |
| Prokinetics | Prucaloprid | 1 |
| Antiparasitics | Fenbendazole | 1 |
| Choleretics | Ursodeoxycholic acid | 1 |
| Platelet aggregation inhibitors | Clopidogrel | 1 |

varied (see Table 1). At least three dogs experienced a relapse with similar symptoms (from 1 to 4 months after initial discharge), all of which were successfully treated conservatively antibiotic treatment without further invasive diagnostics or repeat biopsies.

## DISCUSSION

Contrary to the perception that there had been an increase in cases of idiopathic purulent mLAd/mLAb in dogs, this disease entity was uncommon during the time frame analysed. A search of the veterinary literature identified only single case reports or small case series, some of which were in other intra-abdominal locations (Beaumont & Glauberg 1979, Macpherson 1992, Campbell 2009, Marvel & Macphail 2013), making this the first larger report, including 14 cases from 10 years. Common characteristics of the dogs with this condition included non-specific and GI-related clinical signs, abdominal pain and pyrexia. Typical laboratory abnormalities were consistent with systemic inflammation (inflammatory leucogram with left-shift, mild hypalbuminaemia with mild hyperglobulinaemia, moderate hyperfibrinogenaemia, increased D-dimers, increased CRP) and hepatobiliary involvement in some cases (mild hyperbilirubinaemia and elevated alkaline phosphatase). Urinalysis results ranged from normal to indicative of inflammation/infection, but bacterial urinary culture was negative in all cases in which it was available. The remainder of the performed investigations failed to identify an underlying cause of the mLAd/mLAb, but the extent of the workup varied. This inconsistency reflects the retrospective nature of the study (no standardised diagnostic or therapeutic approach), differences in presenting complaints driving the investigations, and in availability of diagnostic tests over the years. Interestingly, bacterial growth was only identified in 50% of cultures performed. Similar to previous reports (Macpherson 1992, Campbell 2009, Marvel & Macphail 2013), this included isolates typically associated with the skin, e.g. *Staphylococcus* and *Streptococcus species*, or the GI tract. A small amount of bacteria from the GI tract (including microorganisms from the oral cavity and possibly skin) migrate to the mesenteric lymph nodes under physiological conditions, usually within antigen-presenting cells (macrophages, dendritic cells) (Alexander *et al.* 1990, Dahlinger *et al.* 1997, Macpherson & Smith 2006). This is part of the innate immune system of the GI tract (gut-associated lymphoid tissue) recognising and processing GI microbes, thereby maintaining tolerance towards harmless commensal microorganisms (Macpherson & Smith 2006). However, if the intestine is inflamed or the physiological architecture destroyed, bacterial translocation with subsequent intra-abdominal or systemic inflammation (systemic inflammatory response syndrome; SIRS) and, or, sepsis can occur (Qin *et al.* 2002, Goddard & Leisewitz 2010, Unterer *et al.* 2015). Because some dogs described in this report fulfilled SIRS criteria (Purvis & Kirby 1994, Gebhardt *et al.* 2009, Torrente *et al.* 2015), bacterial translocation or haematological spread from a distant unrelated and undetected site is a possible pathogenesis. Pancreatitis, which is a valid differential diagnosis in dogs with acute to sub-acute GI signs, pyrexia and an inflammatory leucogram, has been associated with bacterial translocation in both humans (Kazantsev *et al.* 1994) and dogs (Qin *et al.* 2002). Intestinal biopsies to assess possible GI disease or comprehensive faecal examinations for potential intestinal pathogens (bacterial, parasitic, viral) were not available in most of the cases presented here, therefore primary intestinal inflammation or infection cannot be ruled out. Pancreatitis was not detected in any dog based on measurement of non-specific serum lipase activity, which is part of the routine biochemical profile of our teaching hospital for more than 10 years. However, more specific cPL (Haworth *et al.* 2014) was only assessed in four cases (all within normal limits). In none of the dogs were findings of the abdominal ultrasound examination particularly suspicious for pancreatitis but, again, it cannot be entirely excluded (Xenoulis 2015). While ultrasonographic examination of the pancreas has improved dramatically with equipment advances, the sensitivity for correctly diagnosing pancreatitis with ultrasound remains only around 70% (Hess *et al.* 1998, Shanaman *et al.* 2013, Xenoulis 2015). Sensitivity for diagnosing of pancreatitis using cPL ranges between 72 and 78% (McCord *et al.* 2012), therefore pancreatitis cannot be excluded from the patient population investigated here.

It also has to be considered that the bacterial species isolated from mesenteric lymph nodes in these cases may not represent the initial causative agents, making speculation on the significance of these findings even more difficult. Other bacterial organisms, such as anaerobes, *Bartonella* species or mycobacteria, have not consistently been investigated and so it is possible that they have been overlooked. However, even though *Bartonella* species (Pappalardo *et al.* 2001, Morales *et al.* 2007, Tucker *et al.* 2014) and

mycobacteria (Zeiss *et al*. 1994, Grooters *et al*. 1995, Turinelli *et al*. 2004, Campora *et al*. 2011, Martinho *et al*. 2013) undoubtedly have their place in causing lymphadenopathy, lymphadenitis and/or lymph node abscesses in dogs, the expected histopathological changes would be of granulomatous or mixed inflammatory nature rather than purulent inflammation (Zeiss *et al*. 1994, Grooters *et al*. 1995, Pappalardo *et al*. 2000, Turinelli *et al*. 2004, Saunders & Monroe 2006, Morales *et al*. 2007, Campora *et al*. 2011, Drut *et al*. 2014, Tucker *et al*. 2014). Primary immune-mediated disease leading to increased transport or decreased clearance of bacteria from the mesenteric lymph nodes can also not be excluded.

The majority of the dogs discussed here were treated surgically, mainly because mesenteric lymph nodes showed signs of abscessation on ultrasonography or septic peritonitis was diagnosed. This naturally introduces a bias towards dogs with only mild (often multiple) affected mesenteric lymph nodes (lymphadenitis) and no ascites being treated conservatively. Interestingly, a number of dogs suffered relapses with lymph node abscessation (without ascites) when surgery was not an option for the owner and repeat treatment with antimicrobials lead to resolution of clinical signs. This suggests that conservative management of mLAd/mLAb may be an effective option when surgery is not possible, especially in cases without septic peritonitis. However, it does not allow prediction of the best possible treatment or fair comparison of conservative versus surgical therapy in these cases. It seems prudent that, for septic peritonitis or severe lymph node abscessation with risk of rupture, surgical intervention is still considered the best therapeutic option, until strong evidence is available that proves otherwise.

In conclusion, the combination of GI signs, specifically abdominal pain, and pyrexia in dogs with mesenteric lymphadenopathy warrants a thorough and problem-oriented approach to search for an underlying pathology. Bacterial translocation from the GI tract may potentially contribute to mLAd/mLAb in dogs (either primary or because of an underlying inflammatory or infectious disease of the GI tract, the pancreas or other intra-abdominal organs) but the best approach to diagnostic workup and ideal treatment still needs to be defined. It can be assumed that, depending on the severity and duration of these processes, there are different stages of the inflammatory process within the lymph nodes (from mild suppurative lymphadenitis to rupture of lymph node abscesses), which require different treatments. Once the abscess is fully formed, or if there is concurrent evidence of septic peritonitis, surgical therapy is likely to be a successful and safe treatment option with a good long-term prognosis. Relapses seem to be relatively uncommon, and if they occur, can likely be managed conservatively. The ideal length of antibiotic treatment or the usefulness of prophylactic diagnostic or therapeutic interventions remains unknown. Prospective studies investigating more cryptic pathogeneses more consistently (e.g. infectious diseases that were not routinely assessed and concurrent organ diseases) or determining the relevance of isolated bacterial organisms would be useful, because a primary immunopathogenesis with secondary infection cannot be excluded at this stage.

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## Conflict of interest

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