Received: 16 July 2024 | Revised: 6 December 2024 | Accepted: 28 December 2024

DOI: 10.1002/vrc2.1084

Vet Record CaseReports

CASE REPORT

Companion or pet animals

Intracardiac lymphoma in a cat: Diagnosis and response to chemotherapy treatment

Marianne Lappalainen | **Virginia Luis Fuentes** | **Julia Sargent** | **Isabelle Desmas-Bazelle**

Royal Veterinary College, Hatfield, UK

Correspondence
Marianne Lappalainen, Royal Veterinary College, Hawkshead Lane, Hatfield, UK.
Email: mlappalainen21@rvc.ac.uk

Abstract

A three-year-old female cat presented for further investigations for pleural effusion following a short period of weight loss, lethargy and hyporexia. A computed tomography scan and echocardiography showed a right atrial wall mass, of which cytology was consistent with lymphoma. The heart was the sole organ infiltrated based upon extensive staging confirming a primary cardiac lymphoma. The cat was started on a multidrug chemotherapy protocol and achieved complete remission with a good quality of life prior to relapsing of her lymphoma in the kidneys and intestine. She died shortly after relapse, 5 months following diagnosis, with no response to the rescue chemotherapy.

KEYWORDS
cardiology, cats, lymphosarcoma, neoplasia

BACKGROUND

Lymphoma is the most common feline haematological neoplasm. In cats, the alimentary tract is the most commonly diagnosed primary site,[1,2] but other extra-nodal sites, such as the nasal cavity, kidneys and mediastinum, are frequently involved.[3] Primary cardiac tumours are rare in cats and are typically malignant, with an overall incidence of 0.027%.[4] While haemangiosarcoma is the most common primary cardiac tumour in dogs, both primary and secondary lymphoma predominate in feline cardiac neoplasms, although this is supported by scarce literature.[5] Anatomical location has been shown to play a role in prognosis in feline lymphoma.[1–3] Few case reports and one case series have shown that primary cardiac lymphoma (PCL) often carries a poor prognosis. In these reports most cats were either not treated or died shortly after starting chemotherapy.[4–8] One of the consistent prognostic factors for cats with high-grade lymphoma is response to treatment.[1,9,10] In the previous case series, the only cat that experienced a long survival time was treated with a multidrug chemotherapy protocol, whereas single agent doxorubicin and prednisolone had little effect and resulted in short survival times in the other cases.[7,9,10]

Our case report describes a cat with PCL with a mass effect, achieving complete remission and extended survival time with a standard multidrug chemotherapy protocol. It highlights that despite the previously reported poor prognosis, if complete remission is achieved, a fair prognosis is possible for this rare anatomical form of lymphoma.

CASE PRESENTATION

A 3.3-year-old female spayed Singapura was referred to a multidisciplinary referral teaching hospital for further investigations of dyspnoea and pleural effusion. The cat was reported to have been lethargic and quiet for 2–3 weeks prior to her initial presentation to the primary care practice. On the day of presentation, the cat had suddenly worsened and became dyspnoeic, with an abdominal breathing pattern. Initial investigations revealed pleural effusion. A therapeutic thoracocentesis was performed by the primary veterinarian and 200 mL of clear to yellow-tinged effusion was retrieved. The fluid had a total solid of 25 g/dL based on in-house refractometry, and no further analysis was conducted on it. Furosemide (5 mg PO SID) was initiated prior to referral. The cat had remained otherwise well in herself with normal appetite until the acute worsening. Polydipsia and polyuria were noted after introduction of furosemide.

At presentation to the referral hospital the cat was bright, alert and considered cardio-vascularly stable. Heart rate was 160 bpm and there was no audible heart murmur or arrythmia. Her thoracic auscultation revealed eupnoeic sounds bilaterally and a respiratory rate of 40 bpm. The weight at presentation was 2.8 kg, with a body condition score (BCS) of 5 out of 9.[11]

INVESTIGATIONS

A point-of-care ultrasound revealed minimal amount of pleural effusion. Diagnostic thoracocentesis yielded 0.5 mL fluid of similar appearance as described by the primary care veterinarian. Cytology of the cytospin showed a lymphocytic effusion, but true classification of the fluid would have required a total nucleated cell count and protein concentration measurement, for which the volume was insufficient. No neoplastic cells were identified in the pleural effusion. An emergency cardiac point-of-care ultrasound was concerning for an intra-cardiac mass lesion. The following day the cat underwent general anaesthesia for a bi-cavitary computed tomography (CT) scan followed by an abdominal ultrasound and echocardiography. Blood work performed at admission, showed mild azotaemia with a creatinine concentration of 228 µmol/L (reference values: 74.5–185.3 µmol/L) and mild non-regenerative anaemia, with a haematocrit (HCT) of 33% (reference interval (RI): 37%–55%). There were no atypical circulating cells on blood smear evaluation. The cat was feline immunodeficiency virus (FIV)/feline leukemia virus (FeLV) negative. The CT scan revealed a large rounded soft tissue mass in the right atrium, which was mildly contrast enhancing (Figure 1). In addition, moderate amount of pleural effusion was observed with mild sternal lymphadenomegaly (9 mm), as well as a small (7 mm) nodule on the spleen. There were no abnormalities reported on kidneys and intestines. A right-sided intracardiac mass was confirmed with echocardiography, originating from the atrial septum or tricuspid valve and obstructing the outflow from the atrium to ventricle, with a maximal dimension of 23 mm (Figure 2). Cytology was obtained from the cardiac mass via fine needle aspirates performed under ultrasound guidance. Cytology described a moderate number of large lymphocytes with moderate variation in size, round to rarely slightly irregular shaped nuclei (>3× red blood cell diameter). Nuclei contained finely stippled to smooth chromatin with frequently a single large moderately distinct nucleolus or multiple nucleoli, and a scant amount of deeply basophilic cytoplasm, occasionally with low numbers of fine vacuoles. Occasional mitotic figures were seen. Admixed are low numbers of small mature lymphocytes. Interpretation was consistent with large cell lymphoma. Fine needle aspirates of liver and spleen revealed no evidence of lymphoma. The sternal lymph node was not sampled due to its small size and inaccessible location.

DIFFERENTIAL DIAGNOSIS

A cardiac mass can be both benign and malignant but is more commonly malignant in cats. Differential diagnosis for a cardiac mass besides lymphoma in cats includes haemangiosarcoma, chemodectoma or aortic body tumours, ossifying myxoma, rhabdomyosarcoma and angiolipoma.[12–16,17]

TREATMENT

Following diagnosis, the cat was started on a COP-chemotherapy protocol consisting of injectable vincristine, oral cyclophosphamide and oral prednisolone. Due to the possible risk of tumour lysis syndrome and cardiac wall rupture, prednisolone was started at a dose of 1.4 mg/kg PO SID first, and vincristine (0.5 mg/m^2 IV) was administered 48 h later. The cat remained hospitalised, and a repeat echocardiogram performed 24 h following the first dose of vincristine showed a notable reduction of approximately 50% of the original mass size, which was consistent with partial response (PR) according to the human RECIL criteria and as described in cats treated with chemotherapy for lymphoma.[10,18,19] Clinically, the cat remained bright, eating well and having a normal respiratory rate and effort following the start of treatment. Therefore, the cat was discharged and instructed to return 1 week later for re-examination and continuation of the planned treatment protocol.

LEARNING POINTS/TAKE HOME MESSAGE

- Lymphoma is a differential for a right atrial mass in cats.
- Cytology of a cardiac mass in cats is feasible under ultrasound guidance and may help in achieving a diagnosis of cancer.
- Cardiac lymphoma in cats may carry a fair prognosis if a response is seen to multidrug chemotherapy.

OUTCOME AND FOLLOW-UP

At the first re-examination, thoracic auscultation identified a heart rate of 140 bpm, with strong synchronous pulses, no audible heart murmur or arrythmia nor increased respiratory effort or signs of dyspnoea. The cat had experienced Veterinary Cooperative Oncology Group (VCOG) grade II anorexia, weight loss (weight 2.34 kg) during the preceding week and VCOG grade I neutropenia and anaemia were seen on repeat haematology.[20] The HCT had dropped to 23% and was thought to be either related to intrapericardial loss after sampling of the mass, gastrointestinal loss while receiving high dose of oral prednisolone or due to anaemia of chronic illness, or a combination of the above. However, the red blood cell morphology was showing signs of regeneration. On repeat echocardiography, the cardiac mass showed a further reduction in size indicating an ongoing PR,[10,18,19] with the mass no longer visible on many of the standard views. The maximal dimension of the mass was 10 mm compared to the previous 23 mm and the previously described pericardial and pleural effusion had completely resolved. A second dose of vincristine (0.5 mg/m^2 IV) was administered; however, the planned dose of cyclophosphamide (170 mg/m^2 PO: 30 mg total dose) was postponed by 1 week due to the gastrointestinal adverse events and instead supportive care was instituted (maropitant 2 mg total dose PO for 4 days and mirtazapine 1.8 mg total dose every third day). This second dose of vincristine and the cyclophosphamide administered 1 week later caused further gastrointestinal adverse events, which was mainly VCOG grade I anorexia and vomiting.[20] Moreover, the cat continued to lose weight and weighed 2.1 kg at this visit. Therefore, the third vincristine the week after, was reduced to 0.4 mg/m^2 (IV) at the primary care practice. Following the reduced dose of vincristine and with ongoing supportive care

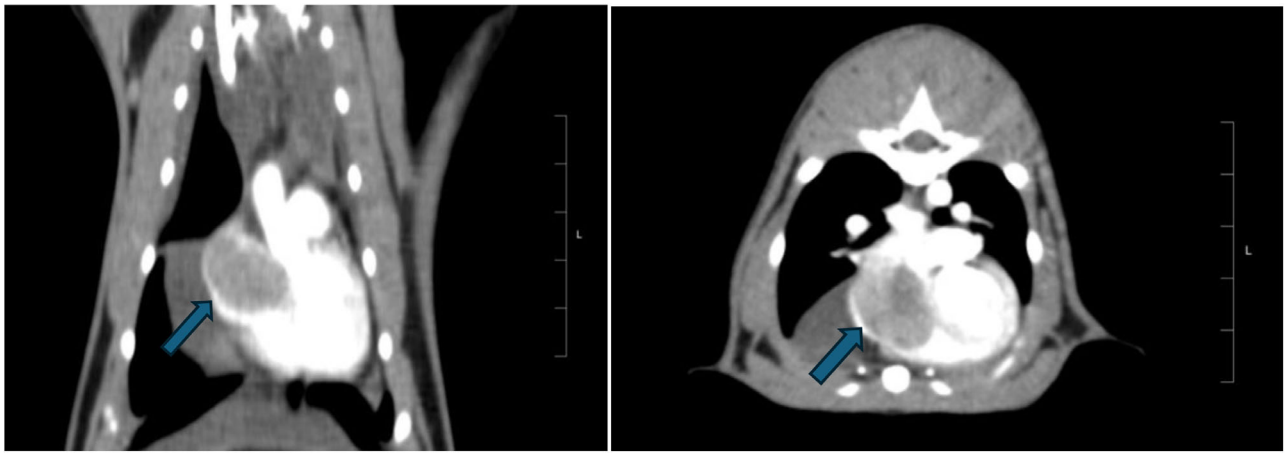

FIGURE 1 Computed tomography (CT) image in early arterial phase post-contrast highlighting a mildly contrast-enhancing right atrial mass, causing a filling defect. The blue arrow indicates the mass in the right atrium.

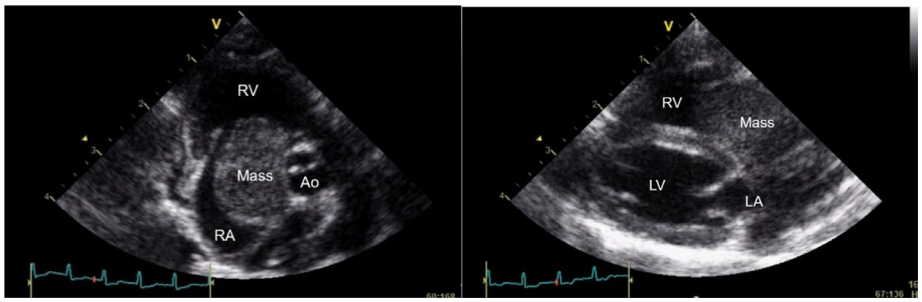

FIGURE 2 Echocardiography images of the right atrial mass at the time of diagnosis.

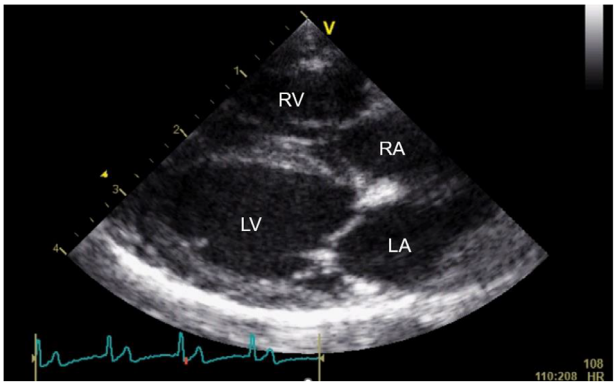

FIGURE 3 Echocardiography image of the heart at 13 weeks post-diagnosis when the cat was in complete remission (CR). Ao, aorta; LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

of oral maropitant the cat showed no clinical side effects at home.

The patient continued to receive the same dose of vincristine alternating weekly with the original dose of cyclophosphamide with the primary care practice until the follow-up examination 5 week later at the referral practice. At this re-examination, 6 weeks post-diagnosis, a continued strong partial remission was observed on the echocardiogram, where the mass was only visible in one oblique view, measuring 4 × 6 mm. As the cat required ongoing antinausea medication, the following six doses of the chemotherapy protocol were substituted for a protocol consisting of bi-weekly injectable vincristine (0.4 mg/m^2 IV) alternating with another alkylating agent; oral chlorambucil (22 mg/m^2: 4 mg PO). The owners were instructed to return after 6 weeks for a re-examination.

The cat presented as planned for its revisit (13 weeks post-diagnosis), where she was reported to be doing well with no clinical side effects from her current chemotherapy protocol. There was a noticeable weight gain compared to the cat's previous visit to the hospital, and her weight was recorded as 2.75 kg, with a BCS 5 of 9. The cat was found to be bradycardic on physical examination with a heart rate of 120 bpm, with no audible heart murmur or arrythmia. The repeat echocardiography showed no visible tumour, confirming a complete remission (Figure 3).[10,18,19] In addition to the echocardiogram, an ECG was performed, which showed a regular rhythm with normal atrioventricular conduction. Isoelectric P-waves in lead II with mean electrical axis (MEAof −20 was suggestive of a focus distant from the sinoatrial node. Occasional supraventricular premature beats and occasional supraventricular bigeminy were observed. The cat was diagnosed with an atrial escape rhythm with occasional supraventricular ectopy. This was suspected to be a consequence of previous damage to the myocardium due to the infiltration by lymphoma. As the cat was in complete remission, it was elected to continue single agent chlorambucil (22 mg/m^2: 4 mg PO) every other week as a maintenance protocol. The following re-examination was scheduled for 5 weeks to assess if remission was maintained.

When the cat presented for the re-examination (at 17 weeks post-diagnosis), her owner reported that she had become quieter at home, but no other marked adverse events were reported. The physical examination revealed an ongoing

bradycardia, and mild weight loss was documented (weight 2.45 kg). The follow-up echocardiogram confirmed ongoing remission of her cardiac lymphoma; however, routine blood test showed mild azotaemia with a creatinine of 189 μmol/L (reference interval: 74.5–85.4 μmol/L) and urea of 15 mmol/L (reference interval: 6.1–12 mol/L) with an inadequate urine specific gravity of 1.021 g/L. A urine culture was negative for a bacterial urinary tract infection. While pyelonephritis or early renal disease were considered possible differentials for the changes seen on blood and urinalysis, early renal involvement of her lymphoma could not be excluded and was raised as a concern. The owners were instructed to have a repeat blood test performed at the local veterinarians 2 weeks following her visit to the referral hospital, especially if the lethargy was becoming more marked or other signs appeared. The chemotherapy dose was reduced (chlorambucil 2 mg PO: 11 mg/m^2) in case of reason to the clinical and biochemical changes.

The cat presented to its referring veterinarians 1 week later, where further weight loss was observed on physical examination, and she was reported to be hyporexic. Blood test revealed severe azotaemia with creatinine of 745 μmol/L (no laboratory range recorded in the history) and an abdominal ultrasound showed loss of normal architecture of her kidneys, as well as a portion of the small intestine showed loss of wall layering and thickening, which were considered likely to be due to lymphoma. Fine needle aspirates of the renal cortex were advised to confirm a diagnosis of lymphoma, but this was not performed by the referring veterinarian. However, lymphoblasts were described in large quantity on the in-house urine sediment, consistent with renal and/or bladder involvement. Subsequently due to secondary organ involvement of her lymphoma, the cat was re-started on vincristine (0.4 mg/m^2 IV) followed by a cytarabine infusion (250 mg/m^2 IV over 6 h) and supportive care with IV fluid therapy, ranitidine, maropitant and ondansetron. The cat remained anorectic, but an improvement was observed in the renal parameters, with a decrease in the creatinine from 745 to 321 μmol/L. A naso-oesophageal tube was placed to support nutrition. As the cat suffered gastrointestinal toxicity from vincristine in the past, it was recommended to consider either vinblastine or L-asparaginase as further rescue treatment. Indeed, vinblastine has been reported to achieve similar outcome in treating feline lymphoma, but with lower associated gastrointestinal toxicity.[21] The cat was seen back at the referral practice 1 week later, where marked renomegaly was palpated on physical examination, yet no abnormalities were audible on thoracic auscultation. Further weight loss was documented (weight 2.3 kg). Repeat blood test showed a moderate anaemia with an HCT of 16% (RI: 37%–55%) and the blood smear documented large round atypical cells that resembled the cells originally described in the cytology from the cardiac mass. The presence of atypical circulating cells was consistent with splenic and/or bone marrow infiltration. The serum biochemistry showed a worsening azotaemia with a creatinine concentration of 469 μmol/L (RI: 74.5–185.3 μmol/L) and urea of 32 mmol/L (RI: 6.1–12 mmol/L). L-asparaginase (400 IU/kg SC) was administered and further supportive care with IV fluid therapy was administered. The cat returned to its primary care practice the following day where, despite treatment, the azotaemia was worsening with a creatinine of 895 μmol/L. Vinblastine (1.2 mg/m^2 IV) was administered as a final rescue treatment; however, the cat died at home the following night after an overall survival time of 148 days following diagnosis. A postmortem examination was not performed. The treatment schedule for the cat is outlined in Table 1.

DISCUSSION

In this case report, we describe a feline primary intracardiac lymphoma achieving a complete remission following chemotherapy, with a prolonged outcome of 5 months despite the previously reported poor prognosis of this cancer entity. The literature is scarce when it comes to outcome and treatment of PCL in cats. The outcome in the eight cats known from previous literature has been days (median survival time MST 9.5 days) with only one cat reported to have had an extended survival time of 750 days.[7,8] Like the cat in our report, most cats in the literature are young with reported poor outcomes and short survival times.[4,6–8]

Cardiac tumours can be either primary or secondary (due to metastatic disease) and malignant or benign in their biological behaviour.[5,7] PCL is rare in dogs, men and cats, with a reported incidence up to 0.02% of all cases in the latter. Cats are more commonly affected by metastatic tumours in that location,[5,8] but the presence of lymphoma in the heart may be underdiagnosed as echocardiography is not part of standard staging procedures. Lymphoma often presents as a diffuse infiltration as opposed to a mass effect, and the challenges associated with sampling the myocardium preclude confirming cardiac infiltration on routine staging. Cardiac tumours, depending on the histological subtype, may arise in various locations of the heart.[5,22] A study reporting location of tumours in the heart showed that most primary tumours affect the right atrium/right atrial auricle, followed by the heart base and the left ventricle.[5] Metastatic lesions are mostly located in the inner third of the left ventricular free wall, the interventricular septum or both. Only approximately a quarter of metastatic lesions are found in the right atrium or right ventricular wall.[5] Cardiac lymphomas in cats have been reported to arise from the myocardium, pericardium, base of the heart and from the left atrial wall.[4,6–8] The lesion in our cat originated from the right atrial septum or tricuspid valve and obstructed the outflow from the atrium to the ventricle by causing a mass effect, emphasising that lymphoma can arise in any location, and that it should remain a differential for any cardiac mass in cats.

The clinical signs, albeit non-specific, reported in our cat, were similar to those previously reported, including weight loss, hyporexia and lethargy.[3] In many cases of cardiac neoplasia, independent of the histological subtype, patients present with signs associated with pericardial or pleural effusion.[6–8,23–25] Depending on the amount of pericardial or pleural effusion, dyspnoea, dull lung sounds and heart sounds may be evident on physical examination. The most common differentials in cats with pleural effusion are heart failure, feline infectious peritonitis or neoplastic disease.[23–25] Neoplastic disease as an origin for pleural effusion is most commonly due to a mediastinal mass rather than a cardiac tumour.[8,23–25] The cause of our cat's pleural effusion was most

TABLE 1 Weekly chemotherapy protocol used for the cat during its treatment for its primary cardiac lymphoma.

Week	1	2	3	4	5	6	7–12	13–16	17	18	19	20
Vinc	0.5 mg/m^2 IV	0.5 mg/m^2 IV		0.4 mg/m^2 IV		0.4 mg/m^2 IV EOW	0.4 mg/m^2 IV EOW			0.4 mg/m^2 IV		
Cyclo			170 mg/m^2: 30 mg PO		170 mg/m^2: 30 mg PO							
Chlor-ambucil						22 mg/m^2: 4 mg PO EOW	22 mg/m^2: 4 mg PO EOW	22 mg/m^2: 4 mg PO EOW	11 mg/m^2: 2 mg PO EOW			
L-asp											400 IU/kg SC	
CytA										250 mg/m^2 6 h CRI		
VBL												1.2 mg/m^2 IV
Pred	1.4 mg/kg PO SID	1.4 mg/kg PO EOD	1.4 mg/kg PO EOD	1.4 mg/kg PO EOD	1.4 mg/kg PO EOD	1.4 mg/kg PO EOD	1.4 mg/kg PO EOD	1.2 mg/kg PO EOD	1.2 mg/kg PO EOD	1.4 mg/kg PO EOD	DexaM 0.3 mg/kg IV	DexaM 0.3 mg/kg IV

Abbreviations: CRI, constant rate infusion; cyclo, cyclophosphamide; CytA, cytarabine; DexaM, dexamethasone; EOW, every other week; L'asp, l-asparaginase; Pred, prednisolone; VBL, vinblastine; Vinc, vincristine.

likely obstruction to venous return by the right-sided intracardiac mass lesion. This is similar to what is observed in human medicine where PCL is reported to affect the right heart more commonly than the left, with dyspnoea being the far most common clinical signs at presentation.[26] While a cardiac mass may be difficult to detect or for that matter sample on diagnostic imaging, cytology has been shown to be an effective and inexpensive method to reach a diagnosis of lymphoma.[5,7,8] Lymphocytes are easily recognised and shed; however, in our cat, the pleural fluid, although lymphocytic, did not consist of the same cells observed on the cytology of the actual mass. Our successful sampling and the consideration of lymphoma in the differential diagnosis of such cases support fine needle aspirates of feline cardiac masses, when feasible.

In the largest case series with seven feline cardiac lymphomas, a median age of only 5 years was reported.[7] Most of the cats reported were FeLV positive. FeLV-positive cats have often been reported to be younger at the time of diagnosis of their lymphoma, specifically mediastinal lymphoma. Although our cat in our study was young, she was found to be FeLV negative.[27,28] Indeed, mediastinal lymphoma is still encountered in young cats, despite the post-FeLV era and despite many cats reported with cardiac lymphoma being FeLV positive, other reports exist with cats that are young and negative for the FeLV.[1,3,6,7,10,28]

Lymphoma is generally considered a systemic disease and the treatment consists of chemotherapy; however, some locations of extra-nodal lymphoma are also treated with radiotherapy or less commonly with surgery.[1,3,9,10] In humans with PCL the outcome can be considered good if a diagnosis is reached promptly and treatment initiated; 1 month without treatment versus up to 5 years with a combination of treatments with immunodeficient humans such as with HIV (human immunodeficiency virus) showing a worse prognosis.[25,29] In many of the case reports of cats with PCL the outcome has been poor, and most cats have succumbed to their disease within days following diagnosis, during investigations or shortly after starting chemotherapy.[4,7,8] However, for canine lymphoma prognosis, which is related to various factors, the most important factor influencing the outcome of feline lymphoma is response to chemotherapy.[1,4,6–10] This was demonstrated in the case series by Amati et al., where the one cat experiencing a long-term survival had achieved a complete remission with a multidrug chemotherapy (modified University of Madison protocol, excluding L-asparaginase) protocol.[7] The reason for so many cats succumbing to this anatomical form might be due to absence of response to treatment, tumour lysis syndrome, or the overwhelming disease affecting the heart especially where disease affecting the myocardium can lead to fatal arrythmias, which is also a reported consequence in man.[3,6,9,10,26,30]

The cat in our case report was started on the COP protocol, which is one of the standard first-line treatments for lymphoma.[10] While many cats have mild but often self-limiting gastrointestinal side effects, this cat appeared sensitive to vincristine and even cyclophosphamide, which eventually resulted in the need to reduce the dose and alter the protocol.[31] Indeed, in the study by Tzennes et al., the reported side effects to the COP protocol for vomiting and anorexia were 23% and 29%, respectively.[31] Nevertheless, we presume that the cat achieved a complete remission based

on the echocardiogram findings, although without cytology, ongoing infiltration of the myocardium could not be fully excluded. At the time of the presumed complete remission, she was changed to another oral alkylating agent, chlorambucil, due to the adverse events affecting the cat's quality of life. Chlorambucil is more commonly used in the treatment of low-grade lymphoma and is generally well tolerated with most side effect being mild[32] as demonstrated by our cat. The common CHOP protocol or COP protocol tends to be continued for approximately 5 months prior to stopping, and it is unknown how long a protocol may need to be continued for, or if a maintenance protocol would improve outcome.[3,9,10] It remains unknown should this cat has tolerated the maximum dose of chemotherapy treatment for longer, could the outcome have been better prior to the relapse of her lymphoma. However, when relapse occurs, as for most cats with lymphoma, then the outcome is generally considered poor. The decision to change to chlorambucil is related to the cat's quality of life; however, its use has recently been described both as a rescue therapy and first-line therapy in two cats diagnosed with large cell lymphoma.[33,34] The use of a slower and lower-dose protocol rather than maximum-tolerated chemotherapy has also been described in the treatment of a primary human cardiac lymphoma.[30]

Our case report shows that although other tumours are more common in this location, lymphoma should remain a differential diagnosis for a right atrial mass in cats and that cytology is feasible and may help to achieve a definitive diagnosis. It also supports and emphasises, should a cat respond well to chemotherapy for its cardiac lymphoma, then it might carry a better prognosis than originally thought. Larger case studies are needed to affirm this assumption and to find the most effective chemotherapy protocol.

AUTHOR CONTRIBUTIONS

Manuscript drafting and revision: Marianne Lappalainen, Isabelle Desmas-Bazelle, Virginia Luis Fuentes and Julia Sargent (Marianne Lappalainen and Isabelle Desmas-Bazelle wrote the paper, and Virginia Luis Fuentes and Julia Sargent revised the final draft). *Project conception and design, gross and microscopic descriptions*: Marianne Lappalainen, Isabelle Desmas-Bazelle and Virginia Luis Fuentes. *Data acquisition*: Marianne Lappalainen, Isabelle Desmas-Bazelle, Virginia Luis Fuentes and Julia Sargent.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

FUNDING INFORMATION

The authors received no specific funding for this work.

ETHICS STATEMENT

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to.

ORCID

Marianne Lappalainen https://orcid.org/0009-0003-1405-7446

REFERENCES

1. Gustafson TL, Villamil A, Taylor BE, Flory A. A retrospective study of feline gastric lymphoma in 16 chemotherapy-treated cats. J AM Anim Hosp Assoc 2001;37(2):159–63.
2. Collette SA, Allstadt SD, Chon EM, Vernau W, Smith AN, Garrett LD, et al. Treatment of feline intermediate- to high-grade lymphoma with a modified university of Wisconsin-Madison protocol: 119 cases (2004–2012). Vet Comp Oncol. 2016;14:136–46.
3. Taylor SS, Goodfellow MR, Browne WJ, Walding B, Murphy S, Tzannes S, et al. Feline extranodal lymphoma: response to chemotherapy and survival in 110 cats. J Small Anim Pract. 2009;50(11):584–92.
4. Magalhães HIR, Mendonça KG, De Paula YH, Romão FB, Barcelos JB, Dobritz WRG, et al. Feline cardiac lymphoma: a case report. Rev Bras Med Vet. 2019;41.
5. Treggiari E, Pedro B, Dukes-McEwan J, Gelzer AR, Blackwood L. A descriptive review of cardiac tumours in dogs and cats. Vet Comp Oncol. 2017;15:273–88.
6. Woldemeskel M. Primary cardiac lymphoma in a cat. J Comp Pathol. 2020;174:34–38.
7. Amati M, Venco L, Roccabianca P, Santagostino SF, Bertazzolo W. Pericardial lymphoma in seven cats. J Feline Med Surg. 2014;16(6):507–12.
8. Shinohara N, MacGregor JM, Calo A, Rush JE, Penninck DG, Knoll JS. Presumptive primary cardiac lymphoma in a cat causing pericardial effusion. J Vet Cardiol. 2005;7(1):65–69.
9. Limmer S, Eberle N, Nerschbach V, Nolte I, Betz D. Treatment of feline lymphoma using a 12-week, maintenance-free combination chemotherapy protocol in 26 cats. Vet Comp Oncol. 2016;14:21–31.
10. Teske E, Van Straten G, Van Noort R, Rutteman GR. Chemotherapy with cyclophosphamide, vincristine, and prednisolone (COP) in cats with malignant lymphoma: new results with an old protocol. J Vet Intern Med. 2002;16(2):179–86.
11. Bjornvad C, Nielsen D, Armstrong J, McEvoy F, Hoelmkjare K, Jensen K, et al. Evaluation of a nine-point body condition scoring system in physically inactive pet cats. Am J Vet Res. 2011;72(4):433–437.
12. Willis R, Williams AE, Schwarz T, Paterson C, Wotton PR. Aortic body chemodectoma causing pulmonary oedema in a cat. J Small Anim Pract. 2001;42(1):20–23.
13. George C, Steinberg H. An aortic body carcinoma with multifocal thoracic metastases in a cat. J Comp Pathol. 1989;101:467–69.
14. Merlo M, Bo S, Ratto A. Primary right atrium haemangiosarcoma in a cat. J Feline Med Surg. 2002;4(1):61–64.
15. Liggett AD, Frazier KS, Styer EL. Angiolipomatous tumors in dogs and a cat. Vet Pathol. 2002;39:286–89.
16. Campbell MD, Gelberg HB. Endocardial ossifying myxoma of the right atrium in a cat. Vet Pathol. 2000;37:460–462
17. Venco L, Kramer L, Boggio Sola L, Moccia A. Primary cardiac rhabdomyosarcoma in a cat. J Am Anim Hosp Assoc. 2001;37:62
18. Younes A, Hilden P, Coiffier B, Hagenbeek A, Salles G, Wilson W, et al. International Working Group consensus response evaluation criteria in lymphoma (RECIL 2017). Ann Oncol. 2017;28:1436–47.
19. Vail DM, Moore AS, Ogilvie GK, Volk LM. Feline lymphoma (145 cases): proliferation indices, cluster of differentiation 3 immunoreactivity, and their association with prognosis in 90 cats. J Vet Intern Med. 1998;12(5):349–54.
20. LeBlanc AK, Atherton M, Bentley RT, Boudreau CE, Burton JH, Curran KM, et al. Veterinary Cooperative Oncology Group—Common Terminology Criteria for Adverse Events (VCOG-CTCAE v2) following investigational therapy in dogs and cats. Vet Comp Oncol. 2021;19(2):311–52.
21. Krick EL, Cohen RB, Gregor TP, Salah Griessmayr PC, Sorenmo KU. Prospective clinical trial to compare vincristine and vinblastine in a COP-based protocol for lymphoma in cats. J Vet Intern Med. 2013;27(1):134–40.
22. Aupperle H, März I, Ellenberger C, Buschatz S, Reischauer A, Schoon HA. Primary and secondary heart tumours in dogs and cats. J Comp Pathol. 2007;136(1):18–26.
23. Beatty J, Barrs V. Pleural effusion in the cat. A practical approach to determining aetiology. J Feline Med Surg. 2010;12:693–707.
24. Hung L, Hopper BJ, Lenard Z. Retrospective analysis of radiographic signs in feline pleural effusions to predict disease aetiology. BMC Vet Res. 2022;18(1):118.

25. König A, Hartmann K, Mueller RS, Wess G, Schulz BS. Retrospective analysis of pleural effusion in cats. J Feline Med Surg. 2019;21(12):1102–10.
26. Petrich A, Cho SI, Billett H. Primary cardiac lymphoma. Cancer. 2011;117(3):581–89.
27. Louwerens M, London CA, Pedersen NC, Lyons LA. Feline lymphoma in the post-feline leukemia virus era. J Vet Intern Med. 2005;19(3):329–35.
28. Fabrizio F, Calam AE, Dobson JM, Middleton SA, Murphy S, Taylor SS, et al. Feline mediastinal lymphoma: a retrospective study of signalment, retroviral status, response to chemotherapy and prognostic indicators. J Feline Med Surg. 2014;16(8):637–44.
29. Bonou M, Kapelios CJ, Marinakos A, Adamopoulos S, Diamantopoulos P, Foukas PG, et al. Diagnosis and treatment complications of primary cardiac lymphoma in an immunocompetent 28-year old man: a case report. BMC Cancer. 2019;19(1):191.
30. Shah K, Shemisa K. A "low and slow" approach to successful medical treatment of primary cardiac lymphoma. Cardiovasc Diagn Ther. 2014;4(3):270–73.
31. Tzannes S, Hammond MF, Murphy S, Sparkes A, Blackwood L. Owners "perception of their cats" quality of life during COP chemotherapy for lymphoma. J Feline Med Surg. 2008;10(1):73–81.
32. Pope K V, Tun AE, McNeill CJ, Brown DC, Krick EL. Outcome and toxicity assessment of feline small cell lymphoma: 56 cases (2000–2010). Vet Med Sci. 2015;1(2):51–62.
33. Takahashi K, Baba T, Hirokawa M, Miyajima M, Kishimoto M, Kimura J, et al. Long-term management of a cat with nasopharyngeal lymphoma by chlorambucil. Open Vet J. 2021;11(2):217–21.
34. Goto S, Muto F, Iwasaki R, Mori T. Successful rescue treatment using chlorambucil for presumed recurrence of sinonasal lymphoma in a cat. J Feline Med Surg Open Rep. 2023;9(1).

How to cite this article: Lappalainen M, Luis Fuentes V, Sargent J, Desmas-Bazelle I. Intracardiac lymphoma in a cat: Diagnosis and response to chemotherapy treatment. Vet Rec Case Rep. 2025;e1084. https://doi.org/10.1002/vrc2.1084

OWNER'S PERSPECTIVE MULTIPLE CHOICE QUESTION

What is considered to be the most reliable prognostic factor for a long-term outcome for a cat diagnosed with lymphoma?

POSSIBLE ANSWERS TO MULTIPLE CHOICE QUESTION

a. Anatomical location
b. Achieving a complete response to treatment
c. Phenotype of lymphoma
d. FIV+ status

CORRECT ANSWER

b. Response to treatment. While some anatomical locations are known to have a prolonged outcome compared to others, the cat's ability to reach a complete remission has consistently been shown to be the most important prognostic factor for the outcome of the patient in achieving a long-term outcome.