Computed tomographic findings and clinical features in dogs with canine cutaneous lymphoma: 10 cases (2007–2018)

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OBJECTIVE

To report clinical features, CT findings, treatment protocols, and outcomes for dogs in which canine cutaneous lymphoma (CCL) was diagnosed.

ANIMALS

10 client-owned dogs with CCL.

PROCEDURES

Medical records of dogs in which a diagnosis of CCL had been made between September 2007 and July 2018 and in which CT had been performed prior to treatment were reviewed. All available CT studies were reviewed, and an anatomical reference system was developed to map observed lesions. Treatment protocols and patient outcomes were summarized.

RESULTS

14 CT examinations were performed on the 10 dogs, and 9 dogs had lesions consistent with CCL on CT images. Nodular lesions were present in 8 dogs, and cutaneous or subcutaneous mass lesions were seen in 3. Well-defined, diffusely distributed, contrast-enhancing, cutaneous or subcutaneous nodules were most common; mass lesions were more variable in appearance. Nine dogs had lymphadenopathy, with the mandibular and axillary lymph nodes most commonly affected. Four dogs had confirmed nodal involvement, and 4 had confirmed visceral involvement. Nine dogs received treatment with chemotherapy, and 5 had a complete response.

CONCLUSIONS AND CLINICAL RELEVANCE

Results indicated that dogs with CCL may have a wide spectrum of CT findings. Many of these lesions, including affected lymph nodes, would be unlikely to be detected clinically, suggesting that CT may be a useful modality to assess the severity of disease and for guiding selection of local versus systemic treatment.

Canine cutaneous lymphomas (CCLs) are a heterogenous group of dermatological neoplasms, accounting for approximately 1% of all skin tumors and 3% to 8% of all lymphomas in dogs.[1–3] They may develop as a primary neoplastic process or secondary to extension of multifocal extracutaneous lymphoma. In both scenarios, infiltration and proliferation within the cutaneous tissues by malignant T or B lymphocytes are characteristic.[4–6] Frequently, canine cutaneous lymphomas are categorized into 2 broad histopathological groups: epitheliotropic lymphomas, which are characterized by neoplastic cells with an affinity for the epidermis and adnexal structures (hair follicles, apocrine sweat glands, and sebaceous glands), and nonepitheliotropic lymphomas, which are characterized by diffuse infiltrative disease of the dermis and subcutis.[1,7] Most reported CCLs are epitheliotropic, with epitheliotropic T-cell lymphoma being the best described.[4–6,8,9] There are few reports describing nonepitheliotropic T- and B-cell lymphomas at this time, and the clinical features of the complex spectrum of diseases comprising CCL are poorly understood.[4,5,7,9]

Dogs with CCL can present a clinical challenge, demonstrating an array of skin lesions mimicking other chronic dermatoses. Erythema, plaques, erosions, scales, nodules, hypopigmentation, crusts, and alopecia are all reported.[10,11] Additionally, the prognosis for dogs with CCL is considered poor, with survival times reportedly ranging from a few months to 2 years with treatment.[6,11] One study[6] categorized epitheliotropic lymphoma into cutaneous and mucocutaneous forms, with the latter having a better overall outcome. Still, specific prognostic data are limited, and outcomes remain poorly defined for the various CCL variants. Staging is integral to the management of cutaneous lymphoma in people, for whom a revised tumor-node-metastasis-blood classification system is used.[12,13] This system incorporates physical examination regarding the visual extent of the disease alongside evaluation of the peripheral lymph nodes.[13] Hematology, histopathology, and diagnostic imaging are also required to complete staging.

Computed tomography is a well-established but selectively used modality for assessment of cutaneous lymphoma in people.[14] Historically, CT has been used to identify extracutaneous disease, which is important for staging, treatment planning, and prognostication.[13,15] Abnormal CT findings are present in most people with higher stage disease but in far fewer patients with lower stage disease.[16,17] Computed tomographic findings in people with cutaneous lymphoma include skin thickening, plaques, tumors, and periph-

eral lymphadenopathy.[17] Additional findings such as splenic abnormalities, pulmonary nodules, and lymphadenopathy may also be identified in patients with extracutaneous disease.[16] People with solitary cutaneous lymphoma lesions appear to have a better prognosis and may be successfully treated with surgical excision or radiation therapy.[18,19] As such, use of CT to assess the extent of disease may aid with prognostic and therapeutic guidance.

Use of CT in staging various types of lymphoma in dogs has been described.[20–22] However, in a search of the literature, we were not able to identify any reports describing the clinical features and corresponding CT findings in dogs with CCL. Therefore, the objective of the study reported here was to report clinical features, CT findings, treatment protocols, and outcomes for a series of dogs in which CCL was diagnosed.

Materials and Methods

Case selection criteria

Medical records of the Queen Mother Hospital for Animals were searched to identify dogs in which a diagnosis of CCL had been made between September 2007 and July 2018. Dogs were eligible for inclusion if the diagnosis had been confirmed by means of cytologic or histologic examination performed by a board-certified veterinary clinical pathologist and were included if CT had been performed at or any time after the time of CCL diagnosis but prior to the initiation of treatment. Computed tomographic studies performed after the initiation of treatment were reviewed only if a pretreatment CT study was also available. Ethical approval for the study was granted by the Clinical Research Ethical Review Board associated with the hospital.

Medical records review

Medical records of dogs included in the study were reviewed to identify the method of diagnosis of CCL and, when available, cellular phenotype, immunophenotype, and whether epitheliotropism was present. Immunophenotype was determined by means of immunohistochemical staining, demonstration of a clonal population of T or B cells by means of a PCR assay for antigen receptor rearrangement, or flow cytometry. Additional data obtained from the clinical records included signalment, history, clinical signs, treatment, and any available follow-up information.

CT

All CT images were acquired with a multislice 16-channel scanner (Mx8000 IDT; Phillips International). Typical CT settings were helical acquisition, 3-mm slice thickness, 1.5-mm image reconstruction interval, 0.688 helical pitch, tube rotation time of 0.75 seconds, 150 mAs, 120 kVp, 320 X 400-mm field of view, 512 X 512 matrix, and medium frequency (soft tissue) reconstruction algorithm. Images were obtained before and 60 seconds after IV injection of 300 mg/mL of iohexol solution (Omnipaque; 600 mg of iodine/kg). Dogs were anesthetized or sedated for CT and positioned in sternal recumbency.

All available studies were reviewed by a single board-certified radiologist. Computed tomographic images were reviewed with soft tissue (width, 400 HU; level, 60 HU), lung (width, 1,600 HU; level, −600 HU), and bone (width, 1,500 HU; level, 300 HU) windows.

For purposes of the present study, an anatomical reference system was developed to map observed lesions **(Figure 1)**. A combination of veterinary anatomical textbooks and publications on CT characteristics in people were used to develop this model.[23–25]

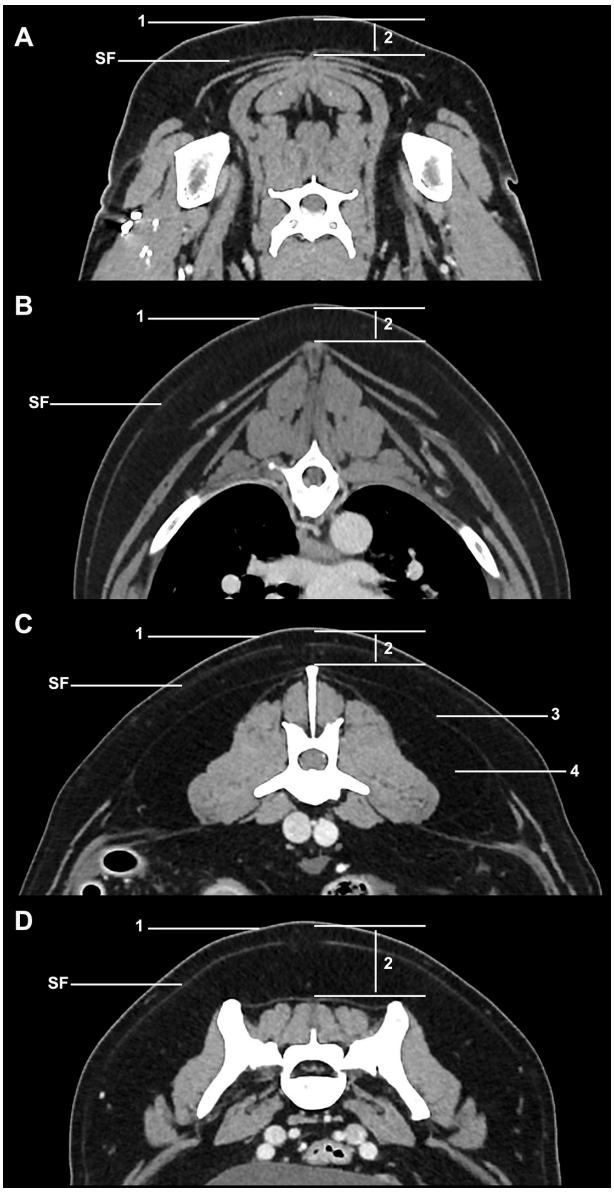

Figure 1—Transverse CT images of the caudal neck (A), midthoracic (B), midabdominal (C), and pelvic (D) regions in a healthy dog illustrating an anatomical reference system developed to allow mapping of cutaneous and subcutaneous CT lesions. 1 = Cutaneous layer. 2 = Subcutaneous layer; within this layer, thin soft tissue bands corresponding to the cutaneous muscles of the neck (platysma muscle) and trunk (cutaneous trunci muscle) with their associated superficial fascia (SF) can be identified. 3 = Deep fascial layer. 4 = Subfascial layer. The intramuscular layer is not labeled but includes all other skeletal muscles.

Five anatomical locations were defined: cutaneous, subcutaneous, deep fascial, subfascial, and intramuscular. The most superficial hyperattenuating line observed was defined as the cutaneous layer, considered representative of the combined epidermis and dermis.[26–29] The fat-attenuating layer immediately deep to the cutaneous layer represented the subcutis and was defined as the subcutaneous layer. Within this layer, thin soft tissue bands corresponding to the cutaneous muscles of the head, neck, and trunk with their associated superficial fascia were frequently identifiable. Deep to the subcutaneous layer, the first soft tissue–attenuating layer represented the deep fascia and was defined as the deep fascial layer. Lesions within the fat deep to this layer were considered subfascial, and lesions identified within muscle were defined as intramuscular.

Each CT study was evaluated for the presence, location, and size of nodular and mass lesions. Cutaneous thickness was not quantified owing to inherent variability among breeds.[30] Lesion distribution was broadly described as focal or diffuse. Nodular lesions were defined as ovoid to rounded, soft tissue–attenuating lesions < 20 mm in diameter; mass lesions were defined as soft tissue lesions > 20 mm in diameter.[31] Nodule distribution was described on the basis of both anatomical location and a numeric scale (absent, < 5 nodules, or ≥ 5 nodules) within the dorsal, middle, or ventral third of a designated body region in transverse section or was classified as associated with an appendage if affecting the limbs or tail. Nodular lesions were also described according to depth within the tissues on the basis of the anatomical reference system. Lesion attenuation characteristics were recorded (pre- and postcontrast radiodensity [HU], margination, perilesional changes, enhancement, and uniformity), with radiodensity measured by placing a single circular region of interest on the largest possible lesion. In the event that lesions demonstrating features consistent with an etiology other than CCL were identified, the medical record was reviewed to clarify the diagnosis when possible.

Documented abnormal lymph node characteristics included abnormal size, loss of hilar fat, and evidence of perinodal changes. Lymph node size was compared with available reported values for healthy dogs.[32–34] Pulmonary, parenchymal, and bony lesions likely attributable to neoplastic infiltration were also reported, as were any other pertinent CT findings.

Treatment and outcome

Details of treatment protocols and outcome at the last point of contact with the hospital were summarized, and median survival times were calculated for dogs that responded to treatment and dogs that did not respond. Survival time was calculated from the date of treatment initiation to the date of death from any cause. Follow-up information was obtained by telephone calls to referring veterinarians when necessary.

Results

Twelve dogs were initially identified for inclusion in the study, but 2 of these dogs were excluded because of a lack of access to histopathological reports. The remaining 10 dogs were included in the study. Mean age at the time of CT was 7.6 years (range, 3.4 to 13 years), and mean body weight was 23.7 kg (range, 6.1 to 54.6 kg). At the time of initial examination, all dogs had cutaneous or subcutaneous abnormalities or both, most commonly masses (n = 8) and erythematous plaques (3). Seven dogs had additional systemic clinical signs including lethargy (n = 4), weight loss (3), vomiting (2), epistaxis (1), glaucoma (1), and generalized edema (1).

A total of 14 CT examinations were performed, with 2 dogs undergoing multiple CT examinations. Four dogs underwent whole-body CT, and 6 underwent regional CT. All 14 CT examinations included a thoracic series, 13 included an abdominal series, and 6 included additional areas such as the head, neck, or hind limbs. Seven dogs had diffusely distributed lesions, and 3 had focal disease.

Canine cutaneous lymphoma lesions were identified in 9 of the 10 dogs and in 13 of the 14 CT studies. One dog with a focal nasal planum lesion did not have CT lesions consistent with CCL. Nodular lesions were present in 8 dogs **(Figures 2 and 3)**, and cutaneous or subcutaneous mass lesions were seen in 3 **(Figures 4 and 5)**. In 2 of the 5 dogs with lesions involving the cutaneous layer, epitheliotropic lymphoma was diagnosed (T-cell lymphoma in one and lymphoma of an unspecified immunophenotype in the other), and in the remaining 3 dogs, nonepitheliotropic B-cell lym-

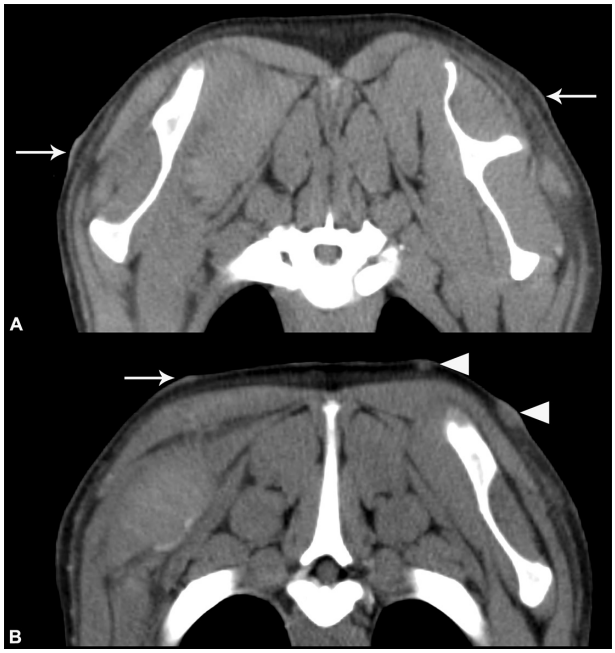

Figure 2—Transverse CT images of the cranial (A) and more caudal (B) portions of the thorax in a 6-year-old American Bulldog with canine cutaneous lymphoma (CCL). Multiple cutaneous (arrows) and subcutaneous (arrowheads) nodules are visible.

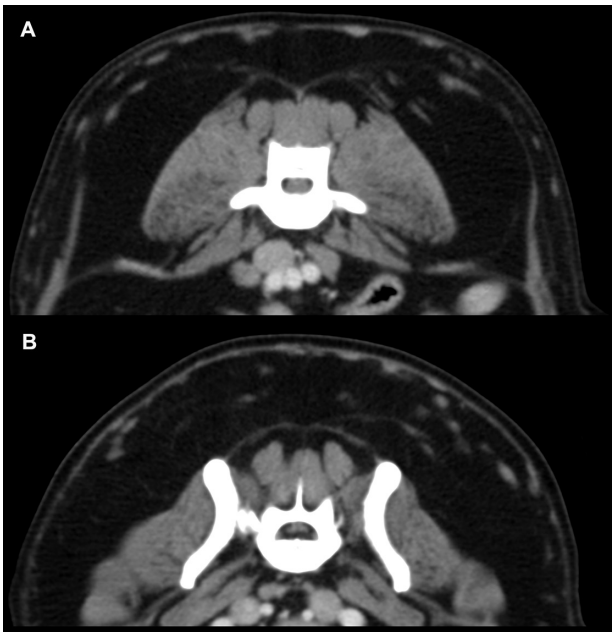

Figure 3—Transverse CT images of the abdominal (A) and pelvic (B) regions in a 7-year-old Cocker Spaniel with CCL. Multiple soft tissue–attenuating nodules are evident in the subcutaneous, deep fascial, and subfascial layers. The nodules are most densely located along the SF.

phoma, unspecified B-cell lymphoma, and unspecified T-cell lymphoma were diagnosed. Three of the 5 dogs with epitheliotropism did not have CT lesions involving the cutaneous layer.

Eight dogs had soft tissue–attenuating nodular lesions, and 6 of these 8 dogs had multiple nodules. Five dogs had large numbers of nodules that could not be reliably quantified. In all dogs with multiple nodules, lesions were dorsally distributed. Five dogs had nodules in the middle third of the body, and 4 had ventrally distributed nodules. Mean maximum nodular diameter was 12 mm (range, 9 to 20 mm), mean precontrast attenuation was 40 HU (range, 20 to 60 HU), and mean postcontrast attenuation was 71 HU (range, 46 to 88 HU), with all nodules demonstrating contrast enhancement. Nodules tended to be uniform in appearance; lesions were well-defined in 7 dogs and had poorly defined margins in 1. Four dogs had perilesional fat streaking, and 1 had presumed diffuse subcutaneous edema. The remaining dogs did not have perilesional changes.

Three dogs had mass lesions consistent with CCL. One dog with epitheliotropic T-cell lymphoma had a discreet, irregular, subcutaneous right tarsal mass lesion. This lesion had heterogeneous contrast enhancement and effaced regional tissue planes. A second dog with T-cell lymphoma but unspecified tropism had an ill-defined prescapular mass lesion with heterogeneous contrast enhancement. This mass extended from the caudal aspect of the neck to the distal left brachial region and merged with the cutaneous margin superficially to efface the subcutaneous fat. The third dog with a mass lesion had epitheliotropic T-cell lymphoma with an ill-defined mass lesion containing

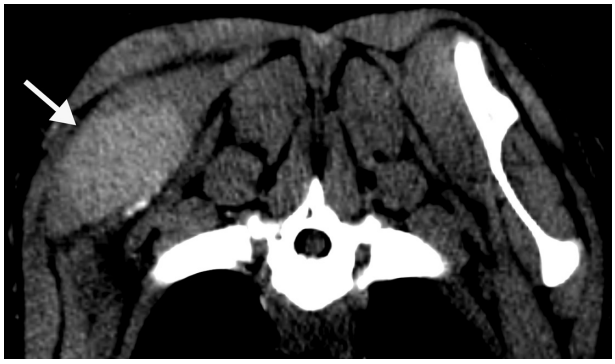

Figure 4—Postcontrast transverse CT image of the thorax in the dog in Figure 2. There is a large, contrast-enhancing mass effect in the thoracic portion of the right rhomboideus muscle (arrow).

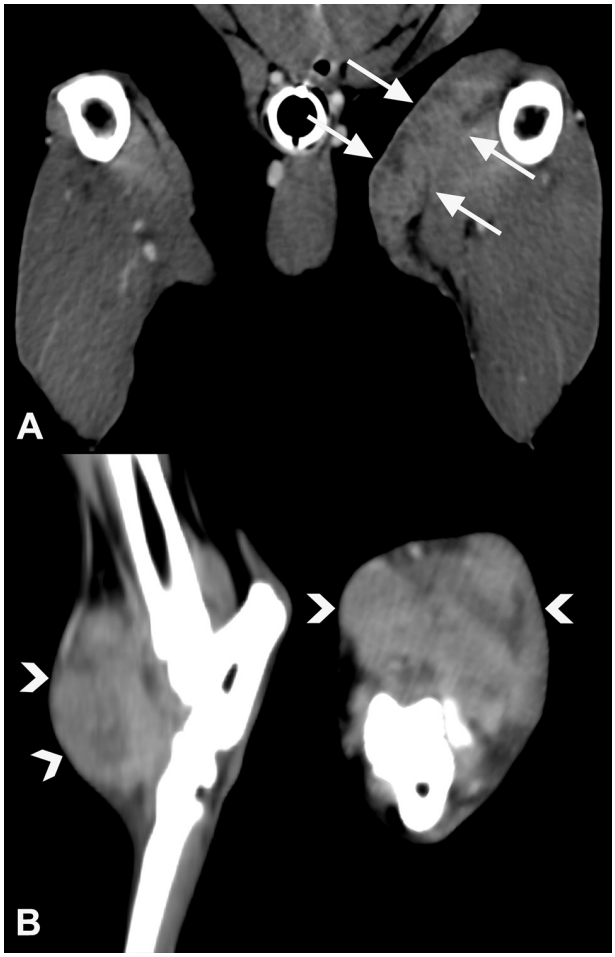

Figure 5—Postcontrast multiplanar–reconstructed CT images of large subcutaneous masses in the left prescapular and medial brachial region (arrows; A) of an 8-year-old Greyhound with CCL and the right tarsal region (arrowheads; B) in a 3-year-old Golden Retriever with CCL.

multiple nodular elements affecting the right pinna. This mass extended into the cutaneous and subcutaneous tissues of both the right aspect of the neck and the proximal aspect of the right forelimb.

Lymphadenopathy was observed involving at least 1 lymph node in 9 of the 10 dogs. The most commonly affected nodes were the mandibular (8 nodes in 5 dog) and axillary (8 nodes in 4 dogs) lymph nodes. Local node enlargement was seen in 2 of the 3 dogs with focal disease; the dog with a right tarsal mass had moderate lymphadenopathy of the ipsilateral popliteal lymph node. The dog with an aural mass had marked ipsilateral superficial cervical, medial retropharyngeal and mandibular lymphadenopathy in association with this lesion. Superficial cervical lymph nodes were not identified as a separate structure in the dog with a prescapular mass.

Two dogs underwent serial CT following the diagnosis of CCL. One of these dogs underwent CT 4 times, with the last study performed 529 days after the diagnosis was made. In this dog, there were progressive reductions in the number and size of nodular lesions over time after initiation of chemotherapy, which correlated with the clinically observed response **(Figure 6)**. A second dog underwent follow-up CT 486 days following the diagnosis, with no abnormalities detected on the follow-up study.

For 7 dogs, cytological or histopathological findings confirmed neoplastic involvement of extracutaneous sites. These sites included lymph nodes (n = 4), liver (1), mediastinum (1), lungs (1), CNS (1), conjunctiva (1), and ocular region (1). Unconfirmed involvement of the mediastinum (n = 1) and heart (1) was suspected in 2 dogs.

In 3 dogs, lymphoma was diagnosed on the basis of cytological findings alone; in another 3 dogs, lymphoma was diagnosed on the basis of histopathological findings alone; and in the remaining 4 dogs, lymphoma was diagnosed on the basis of both cytological and histopathological findings. Cell size was described as intermediate to large (n = 2) or large (7), and 1 dog with large-cell lymphoma had large granular morphology. Cell size was not included in the pathology report for 1 dog. Information on epitheliotropism was available for 7 dogs, with 5 confirmed as having epitheliotropic lymphoma and 2 confirmed as having nonepitheliotropic lymphoma. Immunophenotype was assessed in 9 dogs by means of immunohistochemical staining (n = 5), flow cytometry (3), and a PCR assay for antigen receptor rearrangement (1). Four dogs had T-cell lymphoma, and 4 had B-cell lymphoma; immunophenotype could not be determined in the remaining dog.

Nine dogs received chemotherapy, with 6 dogs receiving lomustine-based protocols, 2 receiving doxorubicin-based protocols, and 1 receiving a combination of vincristine and L-asparaginase. The remaining dog was treated with prednisolone alone. One dog with local disease also underwent additional radiation therapy. Of the 9 dogs that received chemotherapy, 5 had a complete response and 4 did not respond. Median survival time for the nonresponders was 13 days (range, 7 to 25 days). Median survival time for dogs that responded to treatment was 561 days (range, 18 to 1,345 days). Owing to the low number of dogs receiving each type of chemotherapy, meaningful statistical comparisons among treatment groups could not be performed.

Discussion

Results of the present study indicated that dogs with CCL may have a wide spectrum of CT findings. Nodular lesions may be present in the cutaneous, subcutaneous, deep fascial, subfascial, and intramuscular layers. Less commonly, cutaneous or subcutaneous mass lesions may be identified. Many of these lesions, including affected lymph nodes, would be unlikely to be detected clinically, suggesting that CT may be a useful modality to assess the severity of disease. Computed tomography may also be useful for guiding selection of local or systemic treatment protocols and evaluating treatment response. However, the substantial variability in survival times for dogs in the present study likely reflected the heterogeneity of CCL and restricts the prognostic value of CT at this time.

Nine of the 10 dogs in the present study were found on CT to have lesions affecting the superficial tissue layers, with the most common lesions being homogeneously contrast-enhancing, diffusely distributed, cutaneous or subcutaneous, soft tissue–attenuating nodular lesions measuring < 20 mm in diameter. A small (n = 3) number of dogs had focal, heterogeneously contrast-enhancing, cutaneous or subcutaneous mass lesions. Notably, 1 dog had no lesions identifiable on CT despite a nasal planum lesion being evident on physical examination, and an additional 2 dogs had solitary nodular lesions that could have readily been dismissed as clinically unimportant. Both of these 2 dogs, however, had additional lesions consistent with CCL (a prescapular mass lesion in 1 and multiple mass lesions over the flanks and hind limbs in the other), although the lesions

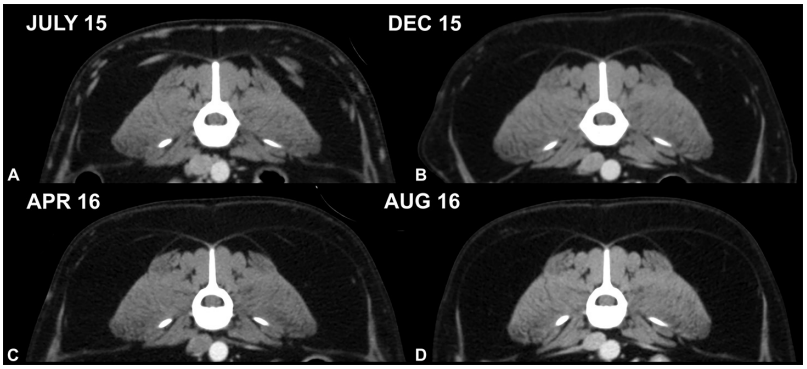

Figure 6—Sequential transverse CT images of the abdomen of the dog in Figure 3 obtained before (A) and during (B through D) treatment with lomustine and prednisolone. Notice the marked reduction in the number and size of nodules following initiation of treatment.

reported in the second dog were not included in the CT field of view. Interestingly, 3 of the 5 dogs with epitheliotropic lymphoma did not have lesions identified within the cutaneous layer. One of these dogs did not have any lesions identified on CT, and the remaining 2 had diffuse lesions within the subcutaneous, deep fascial, subfascial, and intramuscular layers. This finding may reflect the limitations of CT for detection of more subtle, superficial cutaneous lesions associated with CCL or a poor correlation between the anatomical reference system and histopathological cutaneous layers.

A study[17] of people reported that comparatively few patients (30.3%) with cutaneous lymphoma have CT lesions, with cutaneous thickening > 5 mm being the most common finding. Skin thickness was not evaluated for the dogs in the present study because the normal variation in canine skin thickness (ranging from 0.5 to 5 mm in various breeds and anatomical locations[30]) makes interpreting canine skin thickness problematic. Mild thickening may not be readily detectable in dogs, particularly if the thickening is symmetrically distributed. Limitations of CT spatial resolution and additional pathological changes such as concurrent lymphedema may further reduce the reliability of evaluating this feature in dogs. Irregularities and asymmetries in the cutaneous layer could potentially be more reliable indicators of abnormalities; however, these features were not readily appreciated in our study population. Nevertheless, despite the lack of documentation of increased skin thickness, a large number of other lesions were readily detectable. The markedly different CT appearance of cutaneous lymphoma in our population, compared with the appearance in people, likely reflects the inherently different clinical behavior of CCL in dogs or the fact that most dogs had advanced disease at the time of presentation to our hospital.

Limited data are available on the normal CT appearance of skin and other superficial tissues in dogs. For the present study, we developed an anatomical reference system to help localize lesions in various tissue planes by extrapolating data from canine anatomical textbooks and relevant research in people.[15–17,23,24,30,35] Lesions were identified in all layers included in the reference system, with subcutaneous and cutaneous lesions most frequently documented (9/10 dogs). However, lesions within the deep fascial, subfascial, and intramuscular layers were identified in 5 dogs. This may have reflected additional neoplastic foci within various tissues following multisystemic progression of lymphoma or could have represented additional pathological processes. In people with cutaneous T-cell lymphoma, development of secondary invasive squamous cell carcinoma following protracted topical treatment has been described; however, these tumors tended to expand deep to the dermis, rather than forming discrete nodules, and were typically isolated in nature.[17] Alternative neoplastic differential diagnoses for multifocal cutaneous nodules include other round cell tumors (eg, cutaneous histiocytoma), Merkel cell tumors, transmissible venereal tumors, or metastases (eg, adenocarcinoma).[36,37] Nonneoplastic causes include sterile nodular panniculitis, cutaneous histiocytosis, cutaneous sterile granuloma–pyogranuloma syndrome, mycobacterial infection, bacterial folliculitis, cutaneous cysts, mycotic infections, drug eruptions, and foreign body reactions.[38] Unfortunately, a lack of cytological or histopathological data from specific deeper lesions limits further conclusions regarding these findings. Future investigation of such lesions may benefit from the use of CT- or ultrasound-guided sampling.

In addition to lesions of the various superficial tissue layers, lymphadenopathy involving at least 1 lymph node was identified in most dogs in the present study, with the axillary and mandibular lymph nodes most frequently enlarged. Peripheral lymphadenopathy was frequently identified, and lymphadenopathy of various deep nodal centers was also commonly noted, including lymphadenopathy of the sternal, mediastinal, and para-aortic lymphnodal centers. In people, the pattern of lymphadenopathy observed is frequently consistent with the distribution of the disease, with the axillary and inguinal lymphnodal centers most commonly identifiable or enlarged, and deep nodal regions rarely being affected.[15,17] Computed tomography has not been shown to improve the assessment of cutaneous disease beyond physical examination in people, with superficial lesions being variably detectable with imaging.[39] Additionally, visceral involvement does not appear to be a common feature of this group of tumors in people at the time of diagnosis.[15,17,39] Despite this, CT is able to identify systemic involvement that is not readily detected clinically in people, and following lymphoma upstaging, systemic treatment with combination chemotherapy may be recommended in some cases.[17] Involvement of deep lymphnodal centers in our population may reflect an increased prevalence of multicentric lymphoma in dogs or different behavior of CCL subtypes. In our population, extracutaneous disease was frequently verified or suspected, with 4 dogs having confirmed nodal involvement and 4 having confirmed visceral involvement. When present, extracutaneous disease may necessitate an altered therapeutic approach in dogs with CCL, because only focal disease is likely to be addressed with local treatment.

Clinical indicators for using CT in people with cutaneous lymphoma include advanced disease, unexpected lymphadenopathy, and diagnosis of a variant with higher likelihood of extracutaneous disease.[16] In cases of Sezary syndrome or atypical cutaneous lymphoma and in instances in which the subtype is unclear, an increased likelihood of extracutaneous disease may be anticipated.[16] The variety of subtypes present in our study population illustrated the heterogeneity of CCL as an entity, although at this time, subcategorization and behavior of CCL variants are not well-defined. No specific CT features associated with CCL subtype were identified, and similarly, no increased prevalence of extracutaneous involvement was identified in association with CCL subtype. However, this may reflect the small case numbers in the se-

ries. Given the frequency with which extracutaneous disease was identified in our population, the authors advocate the use of bicavitary imaging for staging dogs with CCL. Computed tomography may provide additional information, compared with alternative imaging modalities (eg, combined abdominal ultrasonography and thoracic radiography); however, further research comparing imaging modalities is warranted.

Limitations of the present study include features inherent to its retrospective design, the small number of cases, and the limited sampling of observed lesions and abnormal lymph nodes. Although the most commonly reported type of CCL in dogs is epitheliotropic T-cell lymphoma,[4–6,8,9] our study population included a heterogenous group of lymphoma subtypes, including B-cell lymphoma. Because of the small number of cases, we did not compare treatment responses or survival times with currently published outcomes for various lymphoma subtypes. Ideally, a larger case series with prospective data collection and targeted sampling of lesions seen in various anatomical planes would be performed. A prospective study could also control for the effects of comorbidities; a number of dogs in the present study had additional pathological processes that may have influenced the CT appearance of lesions or altered lymph node characteristics. Additional work to further characterize lesions on the basis of their histopathological subtype would also be of merit, and further development and verification of the anatomical reference system via direct comparison with canine anatomical specimens may be of value. This would allow for more precise anatomical mapping of lesions in dogs with CCL.

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Correction: Variation in mineral types of uroliths from ferrets (*Mustela putorius furo*) submitted for analysis in North America, Europe, or Asia over an 8-year period

In the report "Variation in mineral types of uroliths from ferrets (*Mustela putorius furo*) submitted for analysis in North America, Europe, or Asia over an 8-year period" (*J Am Vet Med Assoc* 2021;259:757–763), values for the crude OR were published for the submission years of 2014, 2016, and 2018 without the tens place. The correct values are 10.37, 10.97, and 14.02, respectively. Table 2 should read as follows:

Table 2—Results of bivariable and multivariable regression analysis to determine variables associated with cystine versus other types of uroliths among the 1,054 submissions described in Table 1.

				Bivariable analysis			Multivariable analysis		
Variable	No. of submissions	Cystine uroliths*	Other uroliths*	Crude OR	95% CI of the crude OR	*P* value	aOR	95% CI of the aOR	*P* value
Ferret age (y)	894	2 (1.3–3.0)†	4 (2.0–5.1)†	0.65	0.57–0.74	< 0.001	0.667	0.578–0.770	< 0.001
Ferret sex						0.170			0.315
Male	797	725 (91.0)	72 (9.0)	Referent			Referent		
Female	213	187 (87.8)	26 (12.2)	1.40	0.87–2.25		1.415	0.719–2.784	
Ferret neutered						0.004			0.159
Yes	829	758 (91.4)	71 (8.6)	Referent			Referent		
No or unknown	225	191 (84.9)	34 (15.1)	0.53	0.34–0.82		0.611	0.308–1.212	
Submission continent						< 0.001			< 0.001
Europe or Asia	41	11 (26.8)	30 (73.2)	Referent			Referent		
North America	1,013	939 (92.6)	75 (7.4)	34.11	16.44–70.76		59.528	21.404–165.557	
Submission year									
2010	14	8 (57.1)	6 (42.9)	Referent			Referent		
2011	18	10 (55.6)	8 (44.4)	0.94	0.23–3.83	0.930	0.743	0.148–3.724	0.718
2012	64	51 (79.7)	13 (20.3)	2.94	0.87–9.98	0.080	2.955	0.731–11.946	0.129
2013	98	86 (87.8)	12 (12.2)	5.37	1.59–18.18	0.007	5.700	1.359–23.907	0.017
2014	178	166 (93.3)	12 (6.7)	10.37	3.09–34.79	< 0.001	12.404	2.937–52.380	< 0.001
2015	139	126 (90.6)	13 (9.4)	7.27	2.18–24.20	< 0.001	8.901	2.228–35.561	0.002
2016	125	117 (93.6)	8 (6.4)	10.97	3.06–39.37	< 0.001	18.279	3.534–94.548	< 0.001
2017	162	142 (87.7)	20 (12.3)	5.32	1.67–6.94	0.005	8.055	1.986–32.682	0.004
2018	256	243 (94.9)	13 (5.1)	14.02	4.24–46.38	< 0.001	21.134	5.078–87.945	< 0.001

*Data are reported as number and percentage of observed events, except where indicated. †Data are reported as median (IQR).