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The Diagnostic Yield of Whole-body Computed Tomography in Dogs and Cats in the Oncology Setting

MARIA DE ALMEIDA[1,2*], HUGO GREGÓRIO[1,3,4*], ANDRÉ PEREIRA[1] and FELISBINA L. QUEIROGA[2,4,5]

[1]Anicura CHV Porto Hospital Veterinário, Porto, Portugal;
[2]Department of Veterinary Sciences, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal;
[3]CESPU, Institute for Research and Advanced Training in Health Sciences and Technologies, Gandra, Portugal;
[4]Animal and Veterinary Research Centre (CECAV), University of Trás-os-Montes and Alto Douro, Vila Real, Portugal;
[5]Associate Laboratory for Animal and Veterinary Sciences (AL4AnimalS), University of Trás-os-Montes and Alto Douro, Vila Real, Portugal

Abstract

Background/Aim: Clinical staging has become essential in veterinary oncology. It is crucial for creating effective treatment plans and predicting outcomes. Whole-body computed tomography (WBCT) can serve as a comprehensive staging examination, offering a detailed view of a patient's internal anatomy. This retrospective study aimed to assess the diagnostic yield of WBCT in diagnosing cancer in dogs and cats.

Patients and Methods: We reviewed medical records of cats and dogs that underwent a WBCT scan between January 2016 and May 2023. Only cases with a confirmed cytological or histological diagnosis of the primary tumor and complete medical records were considered. We collected data on histological diagnoses and diagnostic methods used.

Results: Our study included 57 animals that underwent WBCT for cancer-related reasons. Metastases were detected in 14 dogs, with four showing metastases in multiple locations, five in the lungs, three in the lymph nodes, one in the skeleton, and one in the liver, yielding a diagnostic rate of 31.8%. In cats, metastases were detected in six cases (five in the lungs and one in the lymph nodes), with a diagnostic yield of 46.2%. WBCT identified metastasis in over 35% of cases, including those outside the thoracic and abdominal cavities, indicating potentially greater accuracy than radiography and ultrasound.

Conclusion: WBCT is an effective and safe method for tumor staging and oncological diagnosis in dogs and cats.

Keywords: Whole-body computed tomography, veterinary oncology, dog, cat.

*These Authors contributed equally to this work.

Prof. Felisbina Queiroga, Department of Veterinary Sciences, University of Trás-os-Montes and Alto Douro, Quinta dos Prados, 5000-801 Vila Real, Portugal. Tel: +35 1917826982, e-mail: fqueirog@utad.pt

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Introduction

In recent years, oncology has become a vital area in companion animal clinics because cancer is the main reason for sickness and death among pets (1, 2). The rise in cancer cases among companion animals has prompted veterinary medicine to adapt and evolve, emphasizing the critical role of early diagnosis and comprehensive treatment planning. Clinical staging, in particular, has become an essential tool in veterinary oncology, playing a key role in the pre-treatment evaluation leading to an optimization of the treatment plans and assessment of prognosis (3).

Computed tomography (CT) scan has been described as useful in several oncologic diseases in dogs (4) with sensitivity ranging from 12-83 % for lymph node metastasis in oral and nasal tumors (5, 6); 56% for pulmonary metastasis of osteosarcoma (7); and 87,5% for lymph nodes metastasis in dogs with mammary cancer (8).

Whole-body CT (WBCT) is an advanced imaging modality whose main objective is to comprehensively visualize the animal's internal anatomical structures and pathological changes throughout the entire body in a single imaging session (9). Over the years, its use has significantly increased due to improved accessibility and technological advancements in equipment. Although several areas of veterinary medicine may benefit from this modality, veterinary oncology has derived the greatest benefits from it. Detailed clinical staging becomes a crucial tool within this domain, especially if the primary tumor presents a high metastatic rate (9, 10). WBCT enables thorough staging of oncologic patients, covering anatomical areas beyond the scope of abdominal ultrasound or thoracic radiographs, enabling faster and more accurate diagnoses (9-13).

The diagnostic yield value has emerged as a key metric for comparing diagnostic modalities, characterized by the percentage of positive findings (14). This measure allows for a direct comparison between the effectiveness of different diagnostic tools, with a higher yield indicating a greater capacity to detect pathologies (15). In human oncology, the diagnostic yield value has proven valuable in evaluating screening tests and imaging modalities for cancers, such as colorectal and breast cancer (14, 16). Applying this concept to veterinary oncology, a higher diagnostic yield from WBCT would allow a more effective detection rate of metastatic diseases, thereby underscoring its potential utility in clinical staging (15).

A significant consequence of using more sensitive diagnostic technologies is the emergence of stage migration. Stage migration refers to the phenomenon where the implementation of more sensitive diagnostic technologies, such as WBCT scans, results in a reclassification of disease stages in patients. This reclassification may either upgrade or downgrade the previously determined stage based on the enhanced detection capabilities of advanced imaging modalities. This effect is well-documented within human medicine and has notable implications for treatment planning and prognosis. In veterinary medicine, stage migration has been studied in the context of canine lymphoma. The adoption of these precise diagnostic tools enables clinicians to make more informed therapeutic decisions, potentially leading to improved patient outcomes (17).

Due to various constraints, including accessibility and cost, WBCT has not become widely adopted in veterinary oncology worldwide. Given the limited existing literature, this retrospective study aimed to assess the diagnostic utility of WBCT in cancer evaluations for dogs and cats. The study further analyzed the outcomes achieved with WBCT and to determine its diagnostic yield, thereby contributing valuable insights into its efficacy and application in clinical settings.

Patients and Methods

A retrospective review of clinical records for animals that underwent WBCT exams was conducted. The data were gathered from Anicura Centro Hospitalar Veterinário do Porto, Portugal, covering the period from 1 January 2016 to 31 May 2023, a span of 7 years and 5 months. The computed tomography equipment was the GE Healthcare (Wauwatosa, USA) CT 385 Brivo model (16 multislice).

The database was sourced from clinical records in Orangest® software (Magnisoft, Lisboa, Portugal). The information collected included species, age, sex, breed, neuter status, body weight, body size (for dogs), reason for WBCT, histological diagnosis, diagnostic method (cytology or histopathology), and metastasis site.

All animals were put under general anesthesia for the procedures. The pre-medication protocol combined dexmedetomidine at a dose of 2.5-5 µg/kg with ketamine at a dose of 2.2 mg/kg for cats, and dexmedetomidine at a dose of 2.5-5 µg/kg with methadone at a dose of 0.1 mg/kg for dogs. The pre-medication protocol was adapted to each animal's condition. Induction was performed using propofol at a dose of 1 mg/kg, and each animal was intubated with a specific endotracheal tube. Anesthesia was then maintained using sevoflurane. After completing the anesthesia protocol, the patient was positioned in sternal recumbency on special foam cradles for optimal placement. Typically, two scans were performed: one pre-contrast and another immediately after contrast administration. The contrast agent used was iodine (Omnipaque® 300 mg/ml, GE Healthcare Limited, Buckinghamshire, UK), administered at a dose of 660 mg/kg. The abdominal arterial phase was not included in the scan protocol. The presence/absence of secondary effects (alterations post exam in central nervous, cardio-vascular and respiratory system such as hypersensitivity reactions, bradycardia, arrhythmias, dyspnea, vomiting and/or nausea, diarrhea and fever), associated with the use of contrast was registered. Only animals with complete medical records that underwent WBCT for oncologic evaluation and received a definitive diagnosis of the primary tumor through cytology and/or histopathology were included in the study. With respect to the metastatic lesions, they were subject to fine needle aspiration (FNA) cytology and the metastasis confirmation was achieved, however, this procedure was not performed in all the cases due to inaccessible metastasis location or when its obtention was perceived as a high-risk procedure, or not clinically justifiable by the veterinarian in charge of the case, as per a previously described methodology (18-21). Tumors were categorized into three histologic types based on histological diagnosis: epithelial tumor, mesenchymal tumor, and round cell tumor. If metastatic disease affected more than one organ, the classification of "multiple" was applied. The diagnostic yield value of WBCT was determined by calculating the percentage of exams that identified metastatic disease within the total population studied.

Statistical analysis. All the information was collected and organized in a database created in Microsoft Office Excel® (Microsoft, Seattle, WA, USA), version 2013. This program was also used to elaborate the representative graphics of the variables and for statistical analysis.

Results

Ninety-nine WBCT examinations were collected, of which 22 were excluded as they were conducted for non-oncologic reasons (including trauma and diagnostic investigation of various symptoms like seizures). From the remaining 77 cases, 15 were excluded due to the lack of a definitive diagnosis of the primary tumor. A total of 57 whole-body computed tomography exams were analyzed, with 44 (77.2%) conducted on dogs and 13 (22.8%) on cats. None of the patients included in this study showed any secondary effect related to contrast administration.

Population characteristics. In the canine group, 44 dogs were included in the study, with 21 (47.7%) females and 23 (52.3%) males. The majority were mixed breeds (n=23; 52.3%). The rest were purebreds (n=21; 47.7%), including Labrador Retrievers (n=6; 13.6%), Golden Retrievers (n=4; 9.1%), Boxers (n=3; 6.8%), Yorkshire Terriers (n=2; 4.5%), Beagles (n=1; 2.3%), Bernese Mountain Dogs (n=1; 2.3%), Cavalier King Charles Spaniels (n=1; 2.3%), French Bulldogs (n=1; 2.3%), Portuguese Podengos (n=1; 2.3%), and Shar Peis (n=1; 2.3%). Age information was available for 40 dogs, with an average age of 9.56±3.404 years (range=1-15 years). Weight details were recorded for 35 dogs, with an average weight of 22.35±9.67 kg (range=5.3-42 kg). In the feline group, the study included 13 cats, with nine (69.2%) being female and four (30.8%) male. All cats were of the European

Common breed. The average age was 11.23±3.678 years (range=5-17 years). Weight information was available for 11 cats, showing an average weight of 4.11±0.88 kg (with a minimum of 2.8 kg and a maximum of 5.7 kg).

Tumor histological types. In the canine group, 20 (45.5%) cases were classified as epithelial tumors, 17 (38.6%) as mesenchymal tumors, and seven (15.9%) as round cell tumors. Diagnosis was achieved through cytology in 30 cases (68.2%) and histopathology in the remaining 14 cases (31.8%). Within the epithelial tumors category, carcinomas were the most frequent histological diagnosis (n=20; 45.5%), found in various locations including the mammary gland (n=3; 6.8%), lung (n=3; 6.8%), thyroid (n=2; 4.5%), nasal sinus (n=2; 4.5%), liver (n=2; 4.5%), salivary gland (n=1; 2.3%), stomach (n=1; 2.3%), rectum (n=1; 2.3%), anus (n=1; 2.3%), apocrine gland of the anal sac (n=1; 2.3%), skin (n=1; 2.3%), bladder (n=1; 2.3%), and prostate (n=1; 2.3%). Among the mesenchymal tumors, hemangiosarcomas were the most prevalent (n=7; 15,9%), followed by soft tissue sarcomas (n=3; 6.8%), mesothelioma (n=2; 4.5%), osteosarcoma (n=2; 4.5%), fibrosarcoma (n=1; 2.3%), gastric stromal tumor (n=1; 2.3%), and ovarian granulosa tumor (n=1; 2.3%). In the round cell tumors category, melanoma was the most common (n=4; 9.1%), with histiocytic sarcoma (n=2; 4.5%) and mast cell tumor (n=1; 2.3%) also identified. In the feline group, nine (69.2%) cases were categorized as epithelial tumors, three (23.1%) as mesenchymal tumors, and one (7.7%) as a round cell tumor. Cytology diagnosed the majority (n=9; 69.2%), with histopathology used in four cases (30.8%). Within the epithelial tumor category, the diagnoses were carcinomas (n=9; 69.2%) occurring in various locations: mammary gland (n=5; 38.5%), ears (n=2; 15.4%), salivary gland (n=1; 7.7%), and duodenum (n=1; 7.7%). The mesenchymal tumor category included chondrosarcoma (n=1; 7.7%), osteosarcoma (n=1; 7.7%), and soft tissue sarcoma (n=1; 7.7%). In the round cell tumor category, there was one case of gastric lymphoma (n=1; 7.7%).

Presence of metastasis and their sites. Overall, 20 out of the 57 animals in the study exhibited macroscopic metastatic disease in WBCT scans. Thus, the overall WBCT diagnostic yield for both species (dogs and cats) was 35.1%. In the dog population, metastasis was detected in 14 out of 44 cases through WBCT, yielding a diagnostic rate of 31.8%. The distribution of metastasis included multiple sites in four cases (28.5%) and a single metastatic site in 10 cases [lungs in five cases (35.7%), lymph nodes in three cases (21.4%), bone (tarsus) in one case (7.1%), and liver in one case (7.1%)]. Specifically, metastases were observed in multiple sites as follows: liver and spleen (n=1); lungs, kidneys, and muscle (n=1); lungs, spleen, kidneys, and muscle (n=1); and lungs, lymph nodes, and kidneys (n=1). Three cases showed metastasis in areas outside the thoracic and abdominal cavities, such as the tarsus (bone metastasis, n=1) and lymph nodes [submandibular (n=1) and popliteal lymph nodes (n=1)]. Both lymph nodes presented regular size and were considered normal during physical examination. The bone metastasis was asymptomatic (absence of swollen tarsus; and the patient didn't present limping or other indication of a problem in the pelvic limb). It is noteworthy that the data reveals an absence of brain metastasis among the cases studied (Table I). In the feline population, WBCT scans detected metastasis in six out of 13 cases, resulting in a WBCT yield value of 46.2% for cats. The metastases were located in the lungs in five cases (83.3%) and in the lymph nodes in one case (16.7%). No metastasis was identified outside the thoracic or abdominal cavities. As for dogs, the data reveals an absence of brain metastasis among the cases studied (Table II). Overall, considering the 57 cases included in the study, 14 animals (24.5%) had their treatment plan changed after performing the WBCT. This included surgery not being pursued or euthanasia election due to several distant metastasis.

Discussion

The adoption of WBCT in veterinary medicine has been increasing in recent years. This trend is due to various factors, such as improvements in WBCT technology and a rising recognition of its advantages among veterinarians.

Table I. *Description of metastasis site of the canine population (n=44).*

			Metastasis site						
	Patient (Sex; Age)	Tumor	Lungs	Lymph nodes	Bone	Liver	Spleen	Kidney	Muscle
Epithelial tumors	Female, N/A	Mammary carcinoma		X[a]					
	Female, N/A	Salivary gland carcinoma		X[b]					
	Male, 6y	Prostatic carcinoma	X						
	Female, 12y	Cholangio-carcinoma	X						
	Male, 7y	Hepatic carcinoma	X				X	X	X[f]
	Female, 13y	Pulmonary carcinoma	X			X	X		
Mesenchymal tumors	Male, 5y	Fibrosarcoma	X						
	Female, 11y	Splenic hemangiosarcoma				X			
	Female, 12y	Splenic hemangiosarcoma		X[c]					
	Female, 1y	Splenic hemangiosarcoma			X[e]				
	Female, 13y	Splenic hemangiosarcoma	X					X	X[f]
	Female, 15y	Pleural mesothelioma	X	X[d]				X	
Round cell tumors	Female, 4y	Cutaneous melanoma	X						
	Female, 13y	Cutaneous melanoma	X						

[a]Left iliac and popliteal lymph node; [b]submandibular and retropharyngeal lymph node; [c]hepatic lymph node; [d]mediastinal lymph node; [e]T5 transverse process and tarsus; [f]epaxial muscles. N/A: Not available; y: years old.

Oncology is the field where WBCT is most commonly utilized, especially in tumor staging and pre-surgical planning. Consistent with prior findings (22), the majority of WBCT exams in this study were conducted for staging purposes.

In this retrospective study, 44 (77.1%) dogs and 13 (22.8%) cats were included. To the authors' knowledge, this research is the second to describe the application of WBCT in feline oncology. The first, published in 2013, focused on just 6 cats and specifically examined the CT characteristics of skeletal and cardiac muscle metastases (10). The main objective of the current study was to investigate the presence of metastasis throughout the entire body without focusing on the imaging patterns. The limited literature on the feline species underscores the need for more comprehensive studies on this population in the future. Our findings indicate the value of WBCT in the feline cancer population, where a high diagnostic yield of 46.2% was noted, particularly in cats with mammary tumors (10, 22).

For the canine population, the WBCT diagnostic yield value was 31.8%, indicating that out of 44 WBCT examinations, approximately 14 were instrumental in detecting metastasis. In the realm of human medicine, the impact of WBCT has also been explored. A recent study on Multiple Myeloma revealed that WBCT altered the clinical management in 32 out 116 patients (28%), thereby affirming its significant role in monitoring neoplastic diseases and identifying related incidental findings (23).

Table II. *Description of metastasis site of the feline population (n=13).*

		Metastasis site	
Patient (Sex; Age)	Tumor	Lungs	Lymph nodes
Female, 13y	Mammary carcinoma	X	
Female, 6y	Mammary carcinoma	X	
Female, 7y	Mammary carcinoma		X[a]
Female, 17y	Salivary gland carcinoma	X	
Male, 11y	Duodenal carcinoma	X	
Female, 15y	Squamous cell carcinoma	X	

[a]Iliac lymph node; y: years old.

Although the large collection of different tumor types prevents individual considerations, three patterns were observed: a relatively high yield value in general; a high number of canine cases presenting metastasis outside thoracic and abdominal cavities which would potentially render them undetectable when using conventional staging methods such as thoracic radiography and abdominal ultrasound and a high prevalence of pulmonary metastases in feline mammary tumors. In this study, two cats presented with pulmonary metastasis without obvious lymph node involvement. Feline mammary carcinomas usually spread by the lymphatic route and this may prove lymphography as a potential useful method in the evaluation of sentinel lymph nodes as was observed in female dogs where normal sized lymph nodes were later considered positive with this methodology (24). Moreover, among the 14 animals (dogs and cats) with lung metastasis, four cases (28.6%) presented small pulmonary lesions (under seven mm lesions) that would render them possibly not detectable through conventional radiography. According to the literature, pulmonary nodes tend to not be detected through thoracic radiography if their size is smaller than 7-9 mm and considerable interobserver variability is recorded when using this method (25).

The identification of tumors with multiple metastases affecting various organs together with detection of metastasis in unexpected anatomic locations are significant findings of this study. Four cases were noted to have metastases in multiple locations. One case involved hepatic carcinoma with metastases in the lungs, spleen, kidneys, and muscle (epaxial muscles). Literature indicates that the most common metastasis sites for this type of tumor are the lungs, regional lymph nodes, and peritoneum, with occurrences in the kidney, spleen, and muscle being more unusual (26, 27). Another case was diagnosed as spleen hemangiosarcoma, with metastases found in the lungs, kidneys, and muscle (epaxial muscles). Hemangiosarcoma is known for its aggressive nature and high metastatic rate, commonly spreading to the liver, omentum, mesentery, and lungs, making kidney and muscle metastases less typical (28, 29). A case of pulmonary carcinoma had metastases in the liver and spleen, which are less frequently involved sites since this cancer tends to spread firstly to regional lymph nodes (30, 31). The final case was pleural mesothelioma with metastases in the lungs, lymph nodes, and kidneys. Mesothelioma typically spreads through seeding, and distant metastases are uncommon, with lymph nodes and lungs being the usual sites and kidneys seldom affected (1). With the widespread and routine use of WBCT, it is expected that changes will occur in the prevalence of metastasis sites associated with different types of cancer.

One aspect we would like to highlight is that metastases detected outside the abdominal and thoracic cavities were considered undetectable by clinicians. Specifically, the submandibular lymph nodes, appeared normal during physical examinations. Additionally, there was no swelling in the tarsus, nor was the patient limping. Consequently, the authors concluded that such metastases would not be detected by conventional diagnostic examinations, as thoracic radiographs and abdominal ultrasounds do not cover these anatomical sites. Other metastases that might go undetected with conventional diagnostics include epaxial muscle metastases (two cases in this study). The absence of clinical signs, combined with the complex anatomical location of the epaxial muscles, would make it very difficult to detect these metastases without performing a WBCT (32).

Although we advocate for a wider use of WBCT and other advanced imaging modalities in veterinary oncology, performing complementary examinations in oncologic patients should obey to the principle that the yield obtained should outweigh the cost and risk of performing it. Yield values are better evaluated by the prognostic values they provide (33, 34). One general assumption states that improving diagnostic accuracy leads to improved clinical outcomes. However, this is not always true due to morbidity associated with performing the test or to clinical non-relevant stage migration (34). Examples in veterinary medicine include the use of abdominal ultrasound for staging of multicentric lymphoma and the detection of micro metastasis in regional lymph nodes in dogs with mammary tumors. Both procedures can lead to migration on staging not followed by a worst prognosis (17, 35).

Nonetheless all the above mentioned, it would be very relevant to assess the impact of WBCT and other advanced image modalities in stage migration. Stage migration consists in changing the tumor stage to lower or higher disease stage caused by the use of different diagnostic tools. It is a consequence of the use of more sensitive diagnostic examinations that can detect metastasis leading to different stages. Staging is of paramount importance in oncology as it is directly associated with prognosis and treatment decision. With the advancement of new and more sensitive imaging and molecular diagnostic tools it is predictable that patients could move up the stage grading. This will mean that the average tumor burden in each stage will be less than that in the original grading schemes, which in turn raises the question whether previous prognostic assumptions and treatment decisions are still valid (17, 36, 37).

In fact, many reported staging schemes in several oncologic diseases at diagnosis were performed with conventional imaging technics such as conventional standard radiography and abdominal ultrasound and the use of WBCT would probably mean a reassessment of staging and stage migration in some of these cases. Various staging tests may contribute to this phenomenon depending on the diagnosis. Studies about this specific topic are few and, additionally, tend to have heterogenous population. For this reason, there is a lack of standardization in which diagnostic examination should be performed for each patient (17). WBCT could allow the refinement of staging classifications in some diseases and possibly create new subgroups or new stages and lead to treatment algorithm changes. It may also contribute to a standardization of the examinations used for staging for being such a complete examination. This situation is common in human medicine with advancements in medical imaging more characteristically exemplified by the Will Rogers phenomena where stage migration leads to changes in overall survival in each substage without changing the overall general survival (36, 37). In veterinary medicine, stage migration has been studied, particularly in canine lymphoma. Most studies detected changes in stage previously attributed when recurring to more and more accurate diagnostic methods. Most of them showed a change to a higher stage. Nevertheless, changes to a lower stage were also reported (17, 37).

Fourteen animals (24.5%) had their treatment plan changed after WBCT scan. This included surgery not being pursued or euthanasia election due to distant metastasis. The analyzed reports did not show any accidental findings or *incidentalomas* (findings with no clinical signs) corroborating the literature that indicates a low incidence of occurrence (38, 39). Although radiation effects were never reported in animals, radiation should be taken into consideration when it comes to repeated exams that use x-rays (40, 41).

In our collection of cases, no significant adverse effects were noted, underscoring the safety of the WBCT procedure. This safety, combined with the relatively high diagnostic yield of WBCT, makes it an appealing and potentially invaluable tool in assessing veterinary oncology patients. The importance of WBCT in veterinary oncology, particularly during the staging phase, is relevant. It enables the identification of metastases across any anatomical location or more accurately confirms the absence of macroscopic metastatic disease. In both cases, the data provided by the Tumor-Node-Metastasis (TNM) staging system becomes significantly more precise (3). Despite the diversity of tumor types in our series, mammary tumors in cats – specifically, three positive cases out of a subpopulation of five – appear to be a group where WBCT could play a particularly crucial role in staging and treatment planning.

Study limitations. The direct comparison with other diagnostic examinations such as thoracic radiography and abdominal ultrasound would be beneficial in order to provide more precise results regarding WBCT utility. The fact that some cases could not have the metastasis definitively diagnosed through biopsy or cytology is also a limitation. Biopsy suspected metastasis would allow an unequivocal metastasis diagnosis but could contribute to excess morbidity for the patient or could not be achievable due to its location (18-21). Despite these limitations we want to highlight that the data available in veterinary oncology related to WBCT use is very scarce, which confers actuality and relevance to our study.

Conclusion

The findings of this retrospective study underscore the crucial role of WBCT in the field of oncology. As a complementary examination, WBCT is particularly valuable for accurately detecting metastases across various anatomical sites in tumors known for their high metastatic potential. WBCT facilitated the detection of metastases in over 30% of cases, including sites beyond the thoracic and abdominal cavities. This indicates a potentially higher sensitivity for metastasis detection compared to traditional imaging methods like radiography and ultrasound, underscoring its utility and safety in the staging and diagnostic processes for oncological conditions in both dogs and cats.

Moreover, it is important to consider the emerging role of PET/CT in veterinary oncology. PET/CT, which combines Positron Emission Tomography with Computed Tomography, offers a more advanced imaging technique for the diagnosis, staging, and monitoring of cancer in animals. Its ability to identify and characterize cancerous tissues with greater sensitivity and specificity than WBCT, particularly through the detection of metabolic activity in tumors, presents a significant advantage. Such capabilities allow for earlier diagnosis and more accurate staging of cancer. However, the greater sensitivity and advanced diagnostics come with higher costs and less accessibility compared to WBCT, which may limit its widespread use (3, 41).

To maximize the utility of WBCT in veterinary oncology, future research should focus on expanding our understanding of its diagnostic yield across different types of tumors, particularly in comparison with traditional staging techniques. This involves not only assessing its efficacy in detecting metastases but also exploring how WBCT findings correlate with patient prognosis. Such studies are vital for examining the potential of WBCT to influence stage migration and contribute to the redefinition of treatment algorithms for specific disease subgroups. Given its demonstrated value in accurately detecting metastases across various anatomical sites, enhancing our knowledge about WBCT could significantly improve diagnostic strategies. This, in turn, would help in optimizing treatment plans and improving outcomes for oncological patients in veterinary medicine, especially in regions where advanced imaging technologies like PET/CT are not readily available.

Conflicts of Interest

The Authors have no financial or personal conflicts of interest to declare in relation to this study. The results of the present study resulted from a Master Dissertation performed by MA under the supervision of FLQ and HG.

Authors' Contributions

HG and FLQ conceived and designed this study; HG and AP followed clinical cases; MA performed data collection and database; FLQ and MA performed data analysis; MA wrote the draft version of manuscript; HG and FLQ supervised, reviewed and approved the submitted version. All Authors have read and agreed to the published version of the manuscript.

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