SHORT COMMUNICATION

Non-Invasive Diagnosis and Retrospective Evaluation of Pulmonary Metastasis in Canines

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Abstract

Pulmonary metastasis is a frequent complication of malignant tumours in dogs. Dogs (n=112) diagnosed with pulmonary metastasis in Radiography and Computed Tomography (CT) between August 2024 and July 2025 at MVC Teaching Hospital, Chennai were analysed, retrospectively. Insides of pulmonary metastasis were categorised with respect to sex, breed, age, and lesion with respect to radiographic patterns. Out of 112 cases, 43 were males (38.4%) and 69 were females (61.6%). The most affected breeds were non-descriptive (51), German Shepherd (9), Labrador (18), Spitz (8), Doberman (7), Golden Retriever (4), Shitzhu (4), Rottweiler (3), and others (9). Lesion patterns included diffuse miliary (61), local miliary (32), intra-thoracic mass (8), mediastinal mass (4), nodular lesions (5), and pulmonary osteomata (2). Age distribution showed 1-5 years (16 cases), 5-10 years (46 cases) and 10-15 years (45 cases) were the most affected, with only 5 dogs over 15 years. Fourteen canines were subjected to CT in addition to radiography to reveal the root cause of pulmonary metastasis and its sensitivity. Findings highlight a female predominance, a higher occurrence in middle-aged to geriatric dogs, and the diffuse miliary pattern as the most common radiographic manifestation.

Key words: Canine, Computed Tomography (CT), Pulmonary Metastasis, Radiography.

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Introduction

Pulmonary metastasis is a frequent complication of non-pulmonary malignant tumours in dogs and is often associated with a poor prognosis (Lamb *et al*., 2019). The lung is the most common metastatic site due to its extensive capillary network (Silver *et al*., 2023). While radiography remains the first-line screening tool, its sensitivity for detecting small nodules is limited compared with computed tomography (CT) (Prather *et al*., 2005). Understanding patterns of pulmonary metastasis with respect to age, sex, breed, and lesion type aids in early detection and clinical decision-making. Thoracic radiographs are often performed in animals with suspected or confirmed neoplasia to determine whether pulmonary metastasis is present. Detection of pulmonary metastasis may significantly help in prognosis and course of therapy (Able *et al*., 2021). This information is useful for staging of tumours (Miles *et al*., 1990).

Clinical examination findings in dogs with pulmonary metastasis can often be subtle, primarily affecting the respiratory tract. On thoracic auscultation, an increased broncho-vesicular sound may be present in cases with extensive pulmonary involvement (Mehlhaff and Patnaik, 1984). Additionally, a build-up of pleural effusion in these patients can result in dull lung and heart sounds. While relatively rare, lameness is often a manifestation of hypertrophic osteopathy, a paraneoplastic syndrome linked to both primary and metastatic lung tumours, though it has also been reported in non-malignant conditions. The accuracy of radiographic techniques and reading methods for diagnosis of primary and metastatic pulmonary neoplasia has been studied extensively in human medicine. However, a limited study was present pertaining to canines (Lang *et al*., 1986). Nowadays, thoracic computed tomography (CT) is a popular diagnostic imaging tool for the general and preoperative assessment of patients with pulmonary neoplasia. CT has become more widely available and plays an increasing role in the diagnosis and staging of thoracic diseases in small animals. There are several characteristics of solitary lung tumours that are better appreciated on thoracic CT compared to radiographs in most canine patients (Marcinowska *et al*., 2025). The purpose of this retrospective study was to determine the breed, age, sex, lesion patterns of pulmonary metastasis in dogs with a variety of confirmed primary neoplasms.

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Materials and Methods

The current retrospective study analysed 112 canine cases presented to Madras Veterinary College Clinical Campus, Diagnostic Radiology and Imaging Unit, Chennai, between August 2024 and July 2025. Inclusion criteria required radiographic diagnosis consistent with pulmonary metastatic lesions and confirmation by cytology, histopathology, or necropsy in selected cases. Clinical records were reviewed to extract signalment, radiographic findings and primary tumour information. Thoracic radiographs of 112 dogs diagnosed as having pulmonary metastatic lesion were reviewed. Dogs were not under general anaesthesia at the time of thoracic radiography. Right lateral, left lateral and ventro-dorsal aspects of the thorax were included in each radiographic survey to access the pulmonic metastasis.

For further comparative analysis of pulmonary metastasis, a subset of 14 canines, were subjected to computed tomography (CT). For CT animals were subjected to premedication with inj. Butorphanol @ 0.2 mg/kg BW and inj. Diazepam @ 0.25 mg/kg BW intravenously. For general anaesthesia, premedicated animals were inducted with inj. Propofol @ 3 mg/kg BW intravenously and maintained with Isoflurane (2.5%) under sternal recumbency. Iohexal was used for contrast study. Axial 1 mm cuts were obtained at setting of 120 kvp and 150 Mas from skull to pelvis. Sagittal, coronal reformatting, MPR and 3D reconstructions performed to study the pulmonary metastasis.

Available data were analysed descriptively. Frequencies and percentages were calculated for categorical variables including sex, breed, age group, and lesion type.

Results and Discussion

The dogs having radiographic evidence of single or multiple interstitial nodular opacities, in the absence of known concurrent intrathoracic disease (such as bronchitis), were considered to have pulmonary metastatic disease. When possible, pulmonary metastases were further substantiated by additional diagnostic procedures including CT, fine needle aspirate, trans-tracheal wash, or histologic examination of necropsy tissue. Out of 112 cases, 43 were male (38.4%) and 69 were female (61.6%) diagnosed with pulmonary metastasis, showing a female predominance that correlates with the high incidence of mammary gland tumours in intact females (Otoni *et al*., 2010).

Breed analysis showed non-descriptive dogs were most commonly affected (41/112), followed by German Shepherds (9), Labradors (8), Spitz (8), and Dobermans (7), Golden Retriever (4), Shitzhu (4), Rottweiler (3), Beagle (2), Chippiparai (2), Pug (1) Pomeranian (1), Great dane (1), Lasoaphso (1), and Boxer (1). Large breeds were more frequently represented, consistent with literature linking osteosarcoma to pulmonary spread in these breeds (Silver *et al*., 2023).

Age distribution revealed that 81.3% of cases occurred in dogs aged 5-15 years, reflecting the higher prevalence of neoplasia in middle-aged and geriatric dogs (Dennis *et al*., 2010). Younger dogs (1-5 years) represented 16 cases, likely associated with aggressive tumours such as osteosarcoma. Only 5 dogs were over 15 years, possibly reflecting lower longevity of dogs with advanced cancer.

Lesion distribution showed the diffuse miliary pattern (61/112; 54.5%) as the most common manifestation, followed by local miliary (32; 28.6%), intra-thoracic mass (8), mediastinal mass (4), nodular lesions (5), and pulmonary osteomata (2). This predominance of miliary spread is consistent with reports on mammary carcinoma and hemangiosarcoma (Otoni *et al*., 2010).

The radiography (Fig. 1A,C,E) revealed multiple, well-defined, soft tissue opaque nodules distributed diffusely across all lung lobes, consistent with metastatic neoplasia. Moderate bilateral pleural effusion obscures the lung margins and cardiac silhouette, suggestive of tumour related effusion. Those dogs having radiographic evidence of single or multiple interstitial nodular opacities, in the absence of known concurrent intrathoracic disease (such as bronchitis), were considered to have pulmonary metastatic disease.

The diagnostic value of CT (Fig. 1B,D,F) was also evident. Multiple hyper-attenuating metastatic nodules seen in both right and left cranial, middle and caudal lung lobes was noticed in pulmonary neoplasia in five cases. Fluid attenuation over the ventral thorax suggestive of pleural effusion secondary to metastasis was noted in six distance metastasis cases. Hyper-attenuation of solitary mass in right cranial lobe and consolidation of left caudal lobe was seen in two mesotheliomas and one pulmonary osteomatosis. In our subset analysis, CT detected additional nodules missed by radiographs, particularly those <5 mm. This aligns with the findings of Prather *et al*. (2005), who demonstrated that CT improves staging accuracy and can influence treatment decisions. While radiography remains the most accessible tool, CT is recommended when surgical intervention is considered, especially for osteosarcoma metastasis where solitary nodules may still be resected (Able *et al*., 2021; Silver *et al*., 2023). These results aligned with previously published literature on canine metastatic disease (Prather *et al*., 2005). CT would detect more pulmonary nodules than radiographs, with differences in detection possibly influenced by nodule size and density, patient size, and the particular type of neoplasia (Armbrust *et al*., 2012).

Our findings are in agreement with global trends and necropsy studies confirming the lung as the most frequent

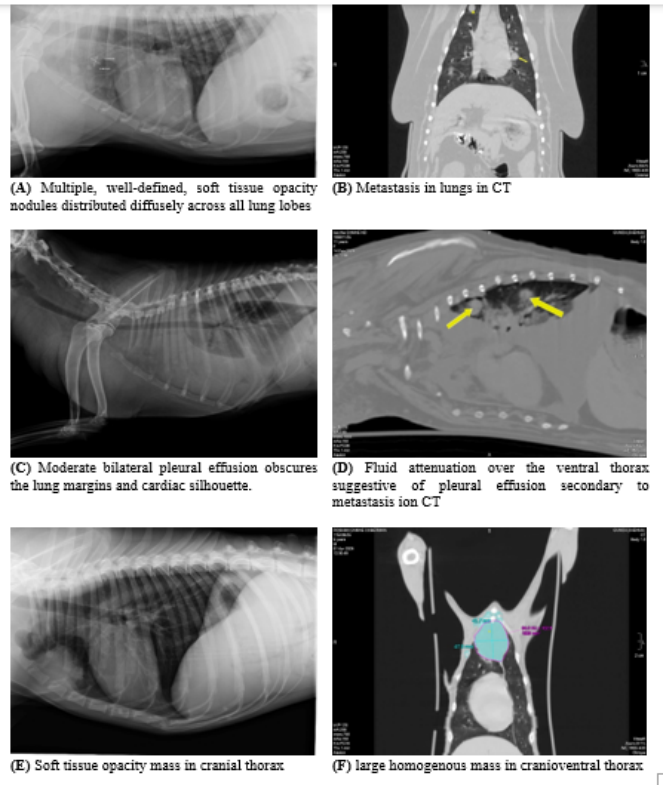


Fig. 1: Radiographic and CT of pulmonary metastasis in various canine breeds

metastatic site. Silver *et al*. (2023) reported pulmonary metastasis in the majority of osteosarcoma cases at necropsy, reinforcing the importance of thorough thoracic screening. Rare presentations such as metastatic spread from meningiomas have been documented (Schulman *et al*., 1992), though no such case was recorded in this dataset.

In conclusion, the present retrospective study showed a clear female predominance, with non-descriptive and large-breed dogs being most commonly affected. The majority of cases occurred in middle-aged to older dogs, and the diffuse miliary lesion pattern was most frequently observed. While radiography is valuable as a screening tool, CT provides superior sensitivity and should be considered in clinical staging where surgical options are under review. Dogs with suspected primary pulmonary neoplasia must be approached systematically to ensure the best care. Thoracic CT remains the diagnostic imaging modality of choice for staging and surgical planning.

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