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CASE REPORT
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Pulmonary Adenocarcinoma in a Bitch - Detection by Multimodal Imaging Diagnostic Methods

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ABSTRACT

***Background*:** Primary pulmonary neoplasia, although considered uncommon in dogs, may have its significance underestimated due to diagnostic challenges. The search for alternatives that provide relevant information for both diagnosis and prognosis is crucial for guiding therapeutic decisions. In this context, the combination of multimodal diagnostic methods and the application of techniques such as elastography and contrast-enhanced ultrasound (CEUS) have shown promising results. These modalities can provide predictive data for malignancy, particularly in patients whose debilitated condition may discourage the use of more invasive diagnostic techniques or those requiring anesthetic preparation.

***Case*:** A 12-year-old bitch mixed-breed, weighing 19.5 kg,was presented with respiratory clinical signs persisting for approximately 1 year, with recent worsening. During physical examination, in addition to the primary complaint, the patient presented nodules in the mammary chain, which cytological analysis revealed an active chronic inflammatory process. Due to the main complaint and the characterization of the nodular structures in the mammary chain, thoracic radiography was requested for pulmonary evaluation. Radiographic findings revealed a pulmonary nodule measuring approximately 6.5 cm in diameter in the right middle lung lobe, along with a predominant unstructured broncho-interstitial lung pattern, dilation of the main bronchi, and dorsal displacement of mediastinal structures. To obtain complementary information regarding the pulmonary neoformation, ultrasonographic techniques - including B-mode imaging, elastography, and CEUS - were performed, all of which suggested malignancy. Additionally, computed tomography (CT) was conducted to further detail the radiographic findings and delineate the lesion's topography and dimensions. The combination of these imaging modalities was fundamental for clinical decision-making and surgical planning. A pulmonary lobectomy was performed to remove the caudal and cranial lobes of the right hemithorax, which were compromised by the tumor and adhesions, along with a tracheobronchial lymphadenectomy (medial and right lymph nodes). Histopathological analysis confirmed malignancy, diagnosing papillary pulmonary adenocarcinoma, with severe bacterial suppurative pneumonia, hemorrhage, and marked focal pulmonary edema in adjacent lung tissue. Additionally, tracheobronchial lymph nodes exhibited hyperplasia associated with reactivity. The patient died 2 weeks after surgery.

***Discussion*:** This case report aims to demonstrate the applicability of multimodal imaging diagnostics in the identification of primary pulmonary neoplasms and the benefits of combining contemporary techniques with those traditionally used in clinical practice for the characterization of malignancy-associated factors and therapeutic decision-making. B-mode ultrasound provided information regarding the shape, echogenicity, and echotexture of the neoformation, along with B-lines adjacent to the altered tissue. Elastography revealed increased stiffness of the pulmonary mass, a finding suggestive of malignancy. CEUS provided details about the tumor's perfusion and contrast enhancement pattern, showing non-homogeneous, centrifugal filling with hypoenhancement in the wash-in, peak, and wash-out phases - features indicative of malignancy. These findings highlight the potential value of these techniques in guiding similar cases and future studies on primary pulmonary neoplasia in dogs, as well as in expanding the routine applicability of CEUS and elastography in veterinary practice.

Keywords: pulmonary adenocarcinoma, malignant neoplasm, multimodal imaging, elastography, contrast-enhanced ultrasound, CEUS, dog.

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INTRODUCTION

Primary pulmonary neoplasms (PPNs) represent an important cause of lung disease in dogs, with adenocarcinoma being the most common type (60%-80%) [12,17,19]. Nevertheless, compared to other types of neoplasia in this species, PPNs are considered rare, accounting for only an estimated 1% of cases [14]. This discrepancy may be associated with various factors that hinder diagnosis, such as nonspecific symptoms, underestimated data due to the absence, misinterpretation, or bias in diagnosis, and limited access to complementary tests for an accurate diagnosis [2,17,18].

A definitive diagnosis of PPNs relies on the identification of neoplastic cells through cytological and histopathological examinations. However, this requires extensive prior clinical investigation and invasive procedures, delaying prognosis and decision-making [20]. Therefore, the combination of multimodal methods capable of providing predictive information about the nature of neoplastic formations is of utmost importance for screening and clinical management. These approaches may facilitate earlier initiation of therapies and even prevent unnecessary or contraindicated treatments. This is particularly relevant given that pet owners are increasingly willing to seek alternatives that enhance their animals' health care and quality of life [6,7,24].

CASE

A 12-year-old mixed-breed bitch, weighing approximately 19.5 kg, was admitted to the Veterinary Hospital of the Faculty of Animal Science and Food Engineering at the University of São Paulo (HOVET-FZEA/USP) in August 2023 with a history of dyspnea associated with coughing and frequent gagging for 1 year. The condition had worsened at night and had shown significant clinical deterioration over the past month.

On physical examination, in addition to the primary complaint, the patient presented with mammary chain nodules (M4 and M5 mammary glands), which were analyzed by cytology and diagnosed as an active chronic inflammatory process.

Due to the presence of mammary chain nodules and the patient's primary complaint of respiratory signs, thoracic radiography was performed to assess pulmonary involvement. Radiographic findings revealed a soft tissue-opacity nodular lesion within the pulmonary parenchyma, measuring approximately 6.6 × 6.5 cm, located in the right middle lung lobe. Additionally, an unstructured broncho-interstitial lung pattern was noted, with dilation of the main bronchi and ventral displacement of the caudal trachea and carina (Figure 1). The radiographic examination was performed using an Altus ST 543 HF[1] X-ray machine, set at 55 kVp and 3.90 mAs, with images captured using a DIGIX WM[2] digital X-ray detector.

Following radiographic evaluation, B-mode ultrasonography and complementary imaging techniques - including contrast-enhanced ultrasound (CEUS) and elastography - were performed to obtain additional information regarding the identified pulmonary mass. All ultrasonographic examinations were conducted using a MyLab™X8VET[3] ultrasound system equipped with multifrequency and matrix transducers. A microconvex transducer (2.5-5 MHz) was used for B-mode evaluation, while a linear transducer (5-10 MHz) was utilized for CEUS and elastography.

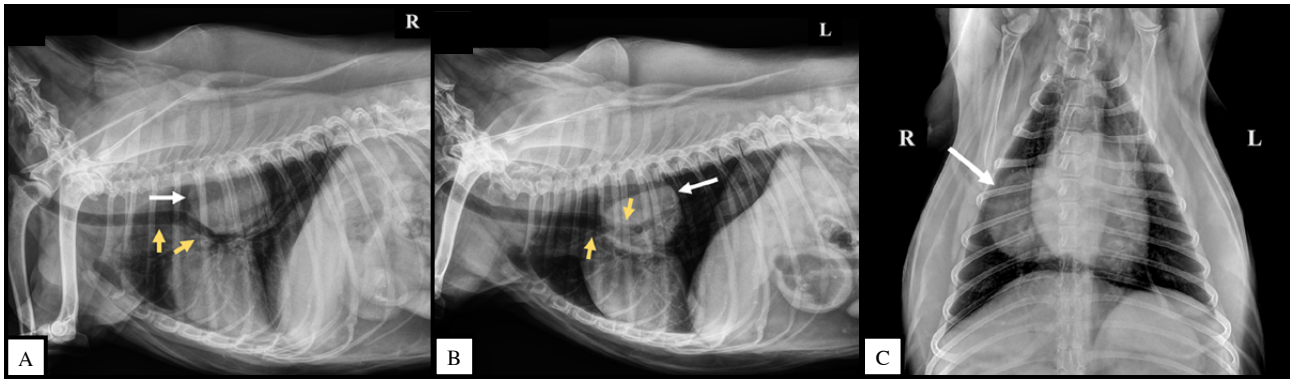

Figure 1. Radiographic examination of the thorax in right lateral (A), left lateral (B), and ventrodorsal (C) projections, showing the presence of a nodular formation with soft tissue radiopacity (white arrow), causing tracheal displacement (yellow arrows). Note the other pulmonary areas with an unstructured broncho-interstitial lung pattern.

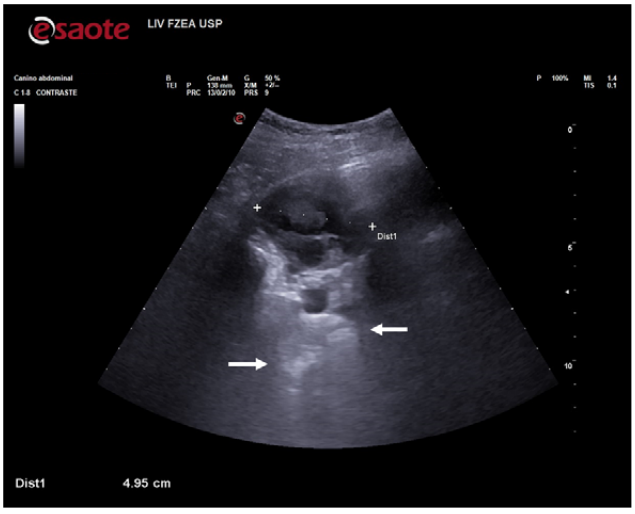

Figure 2. B-mode ultrasonographic examination showing a heterogeneous nodular formation (marked with +) with identification of B-lines adjacent to the lesion (white arrows).

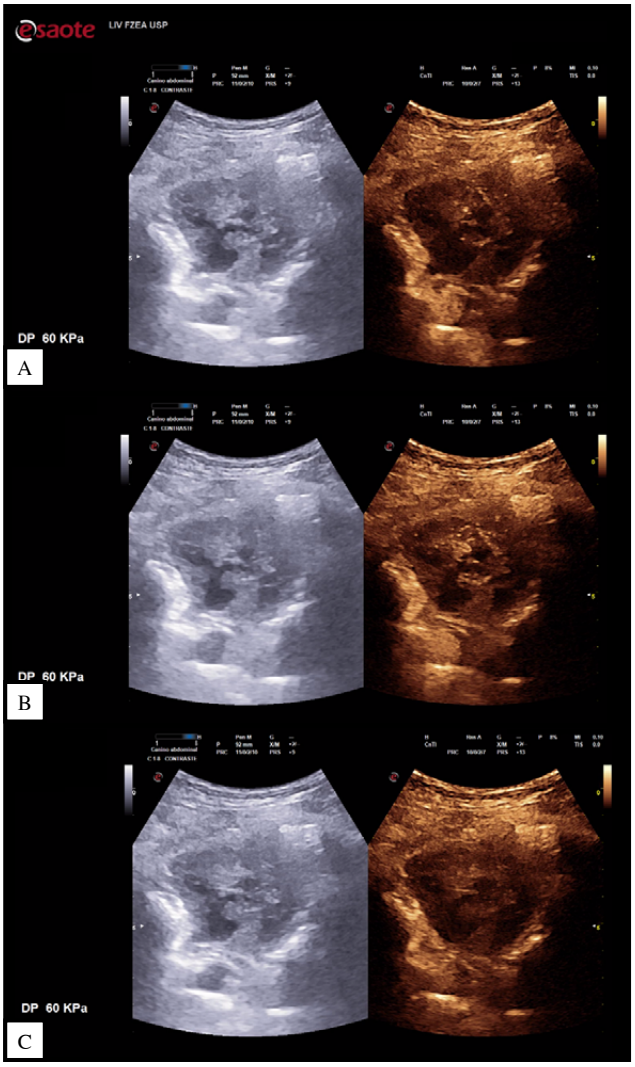

Figure 3. Contrast-enhanced ultrasound (CEUS) showing the neoplasm with non-homogeneous contrast filling and hypointensity of the contrast in the vascular phases of "wash-in" (A), "wash-out" (C), and during peak enhancement (B).

B-mode ultrasonography revealed a pulmonary mass with a round shape, mixed echogenicity, and heterogeneous echotexture, with the presence of both anechoic and echogenic areas. Additionally, B-lines were observed adjacent to the altered tissue and in other areas unrelated to the nodular lesion (Figure 2). CEUS demonstrated a non-homogeneous enhancement pattern with centrifugal perfusion and hypoenhancement of the nodule during the wash-in (Figure 3A), peak enhancement (Figure 3B), and wash-out phases (Figure 3C). Elastographic evaluation indicated that the pulmonary mass had high tissue stiffness (Figure 4). These findings from CEUS and elastography were considered suggestive of malignancy.

Given the imaging findings, thoracic computed tomography (CT) was performed to improve the accuracy of lesion localization and further characterize the pulmonary mass. CT imaging revealed an expansile mass in the right caudal lung lobe, measuring approximately 5.7 cm in diameter, with irregular and

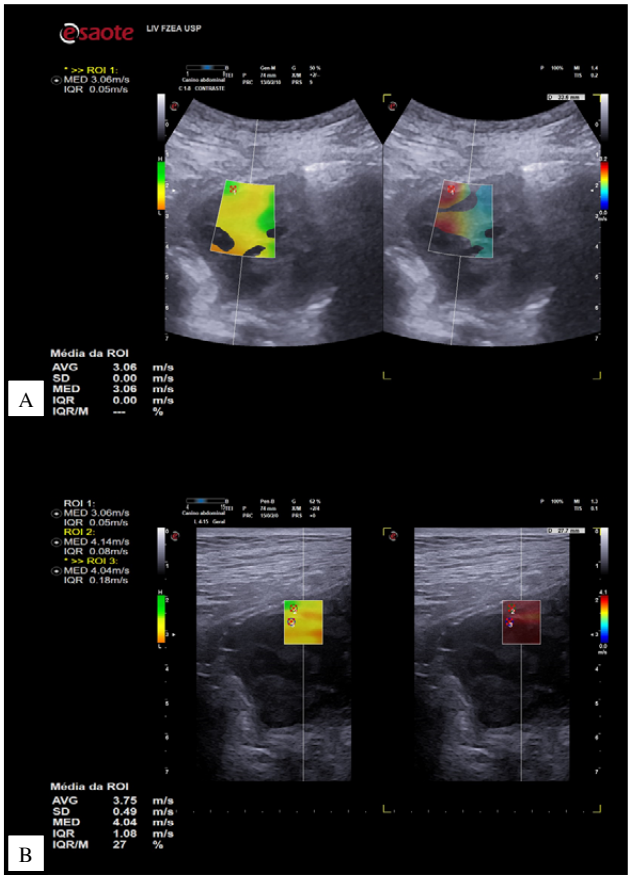

Figure 4. Elastographic evaluation showing areas with increased tissue stiffness identified through 2D SWE quantitative elastography (A-B). Based on the quality graph (image on the left) and elastogram (image on the right). Samples were obtained from different portions of the neoplastic formation, with the average shear wave velocity ranging from 3.06 m/s to 4.04 m/s in the stiffer areas.

Figure 5. Computed tomography images obtained in axial (A), sagittal (B), and coronal (C) planes, providing greater detail of the nodular formation and its topographic location (white arrow). Sensitive information regarding the identification of the patient has been concealed (black rectangles), ensuring anonymity.

well-defined margins, heterogeneous parenchyma, and a predominantly cavitary appearance, along with mild, non-uniform contrast uptake (Figure 5). Additionally, tracheal compression, compression of the right main bronchus and the bronchial branches of the right middle and caudal lung lobes, slight leftward displacement of the esophagus, and signs of bronchopathy were identified. The CT scan was performed using an Aquilion Start[4] scanner, set at 120 kV and 80 mA.

Based on the findings obtained from multiple imaging modalities, the patient was referred for surgical intervention. A pulmonary lobectomy was performed to remove the right caudal and cranial lung lobes, which exhibited adhesion due to the presence of the pulmonary mass in the caudal lobe. Additionally, medial and right tracheobronchial lymphadenectomy was performed due to lymph node hyperplasia.

Following excision, tissue samples were submitted for histopathological analysis. The right caudal lung lobe and pulmonary mass were diagnosed as papillary pulmonary adenocarcinoma, associated with severe bacterial suppurative pneumonia. The right cranial lung lobe sample exhibited focal severe pulmonary hemorrhage and edema, while the tracheobronchial lymph nodes showed hyperplasia associated with reactive changes. Unfortunately, the bitch died 2 weeks after surgery.

DISCUSSION

Corroborating the literature, this case report illustrates the diagnostic steps of an elderly canine patient with primary pulmonary neoplasia presenting with nonspecific respiratory signs. Thoracic radiography was the 1st imaging modality used as an initial screening tool to investigate the nonspecific clinical signs. This approach aligns with previous studies that highlight the preference for radiography due to its accessibility, low cost, and practicality, as well as its widespread use in cases of nonspecific respiratory signs [17,25].

Despite the immediate benefits of thoracic radiography, CT provided a more detailed assessment of the radiographic findings, particularly regarding the nodular pulmonary lesion, diffuse pulmonary pattern alterations, and displacement of mediastinal structures, facilitating therapeutic decision-making and surgical planning. This is because CT has a high accuracy rate (93%) and is capable of detecting lesions as small as 1 mm in diameter. Additionally, it allows for a more precise evaluation and localization of alterations in adjacent structures, such as thoracic lymph nodes, and it enables better preoperative planning [1,17]. In consideration of the patient's clinical signs and overall condition, ultrasonographic examination was prioritized before CT, incorporating CEUS and elastography techniques. These advanced ultrasound methods provided valuable information, as the findings suggested malignancy in the pulmonary mass, later confirmed by histopathological examination. These results reinforce previous studies in both human and veterinary medicine that support the use of these techniques for evaluating different types of neoplasms and detecting malignancy [3,4,6].

B-mode ultrasonography characterized the pulmonary mass in terms of shape, echogenicity, and echotexture, in addition to identifying B-lines adjacent to the altered tissue. This imaging modality has a sensitivity of 60% for detecting peripheral pulmonary

nodules, similar to radiography (64%) [21], but presents certain limitations in assessing deeper thoracic regions [10]. Its use represents a more feasible option for patients with respiratory clinical signs, as it avoids recumbency that may be uncomfortable or compromise the patient's health status, and it does not require anesthetic procedures [15].

Elastography revealed that the pulmonary mass had high tissue stiffness, a finding suggestive of malignancy [3,6,8,13,16]. This technique demonstrates high accuracy (86.7%) in differentiating benign from malignant lesions, approaching the diagnostic reliability of histological examination, which is considered the gold standard [9,11,13].

CEUS provided information regarding the perfusion and contrast enhancement pattern of the pulmonary mass, revealing a non-homogeneous, centrifugal filling pattern with hypoenhancement during the wash-in, peak enhancement, and wash-out phases, suggesting malignancy [5,16,22,23]. This modality has already proven to be highly relevant for malignancy detection when compared with B-mode ultrasonography and elastography [23].

Thus, this case report aimed to provide insights into the presentation of canine pulmonary adenocarcinoma across different imaging modalities and demonstrated how the combination of multimodal techniques can contribute to diagnosis and therapeutic decision-making. These findings are considered valuable for establishing reference parameters that may aid in the management of similar cases and in future studies on PNNs in dogs, as well as on the applicability of advanced ultrasonographic techniques in veterinary medicine.

MANUFACTURERS

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Declaration of interest. The authors declare no conflicts of interest. The authors are solely responsible for the content and writing of the article.

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